

# Aviation Week & Space Technology

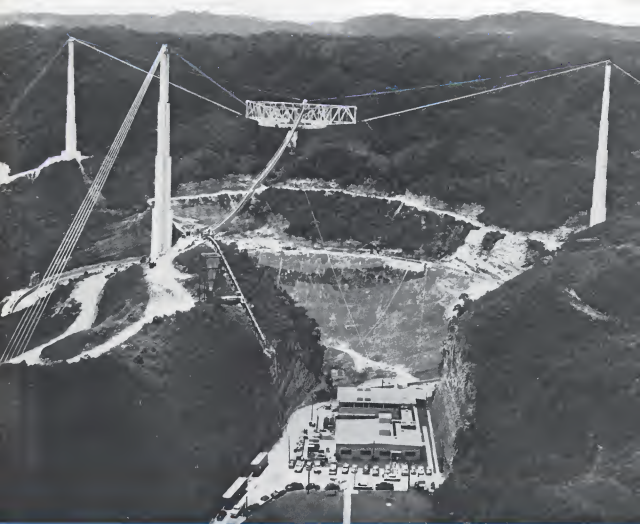
75 Cents

A McGraw-Hill Publication

August 19, 1963

**NAA Studies  
6-Man Logistics  
Spacecraft**

**Radar Telescope Construction  
At Arecibo, Puerto Rico**



**SPECIAL REPORT:**

## Gemini Environmental Control System

# NOW and/or LATER

To get the most out of analog data, you should be able to see it now or see it later, use it now or use it later.

The ideal combination of recording instruments for making the most of your analog data is a Honeywell type recorder, such as the compact Honeywell 8100 portable instrumentation recorder, or the larger, fixed with the Honeywell Visconcord Oscillograph.

For immediate feedback, the Visconcord gives you an instantaneous record of 1 to 36 channels of data from DC to 5000 cycles per second. A variety of paper speeds from 1 to 100 inches per second gives you the trace resolution you need. Five models of the Visconcord are available.

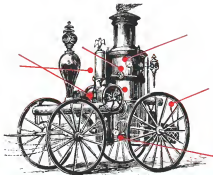
At the same time, you can record up to eight channels (five wave and compensated) of data up to 10,000 cycles on the 8100 portable. Later on, you can play selected portions of your data into the Visconcord. Four tape speeds (1 1/2, 3 1/2, 15, and 30 ips) give you record and playback versatility for whatever frequency you're recording.

In the Honeywell 8100, record head and tape control systems are available including RLLC. All models have a built-in calibration panel, automatic switching of output frequencies, and a new, improved recording that cuts distortion to a minimum and eliminates tape breakage. A built-in standing waveguard noise channel is optional. In addition, Honeywell microprocessors optimize laboratory tape systems with capacities of up to 50 channels on 3-inch tape.

For complete information about the Honeywell 8100, the Visconcord Oscillograph, and other recording equipment, contact your nearest Honeywell office, or write: Honeywell, Denver Division, Denver 10, Colo. Or call or direct at 303/756-4311. In Canada, contact: Honeywell Controls, Ltd., Toronto 17, Ontario.

**DATA HANDLING SYSTEMS**

**Honeywell**



## FORERUNNER OF REACTION CONTROLS?

Wondering what this ancient pump has in common with reaction controls for aerospace applications? They're both based on the science of fluid dynamics.

Vickers has been for more than 40 years with experience on aerospace applications dating back to the early '30s.

Current projects under study or development at Vickers Aerospace Division include: aerospace velocity correction and reentry steering, attitude control systems and components, solid propellant rocket attitude control systems and components and proportional jet gas secondary injection.

For any of these activities, the program manager has at his disposal the specialized skills, experience and facilities available only at Vickers. Groups of specialists in aerothermodynamics, fluid flow, wind, stress, vibration, instrumentation, systems analysis,

velox development, materials and processes provide added assurance of success in attaining all the program's goals.



Vickers developments include a Microjet 30-point thrust rocket motor (left) and a jet thrust downflow motor (right). For more details about these and other recent aerospace developments write for Bulletin # 2001 "Aerospace Fluids for Aerospace Users" to: Vickers Aerospace Division, P.O. Box 201, Troy, Michigan.

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**During the past four years this computer has successfully guided 133 consecutive missiles and satellites and has yet to be charged with a single countdown hold.**

## Quick! What company makes it?

If you know electronic data processing, you know the answer: UNIVAC.

The UNIVAC system referred to is called "ATHENA." It was the first completely transistorized computer ever delivered—back in May 1957. And it has performed reliably ever since. In fact, no comparable device in our nation's space and missile projects can come close to equalling its performance record: reliability of ATHENA is 3500 hours between failures, nearly a half year of continuous operation.

UNIVAC's ATHENA has inserted Echo, Explorer, Tiros, OSO, Agema, Telstar, Relay and Syncom satellites into orbit from both Cape Canaveral and Vandenberg Air Force Base. Today there are UNIVAC ground guid-

ance systems at all Titan I missile sites. A special Air Force plaque honors UNIVAC for "outstanding efforts and significant contribution to the TITAN ICBM Program."

Unusual? Uncommon? Not if you know UNIVAC.

From the yesterday of ENIAC and BINAC, to the fluid mechanics, microelectronics and thin-film magnetic memories of today, UNIVAC has made most of the industry's major technical advances. UNIVAC offers a quick response to every demand... outstanding scientific and engineering talent... total systems programming and management capability. Can this demonstrated competence work for you? Quick...call UNIVAC!

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Qualified in these systems analysis and design, design engineers can facilitate development of the most sophisticated use of UNIVAC, as well as provide general engineering services.

## AEROSPACE CALENDAR

- Aug. 26-28—*Symposium for Aerospace Flight Conference*, American Institute of Aeronautics and Astronautics, Double Hilton Hotel, Columbus, Ohio.
- Aug. 26-28—*Conference on Physics of Entry into Planetary Atmosphere*, American Institute of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, Mass.
- Aug. 27-30—*National Conference and International Data Processing Exhibit*, American Computing Machinery, Donor Hotel, Fort Hood, Texas, Colo.
- Sept. 1-5—*National Control Workshop*, American Society of Tool and Manufacturing Engineers, Thompson Room Workshop.
- Sept. 8-11—*International Symposium on High-Temperature Technology*, Aeronautics, Cold Spring Harbor Research Inst.
- Sept. 8-11—*Annual Meeting of the Institute of Aeronautics*, Mount Richelieu, Mar del Rey, Quebec.
- Sept. 8-20—11th Annual Student Quality Control Institute, University of Cincinnati, Ohio.
- Sept. 9-11—*Research Network Conference on Mission Electronics*, Institute of Electrical and Electronics Engineers, Sheraton Hotel, Washington, D.C.
- Sept. 9-12-13—*Annual Instrumentation-Automation Conference & Exhibit*, Instrument

(Continued on page 7)

## AVIATION WEEK & Space Technology

August 18, 1962

Vol. 70, No. 5

**AVIATION WEEK & SPACE TECHNOLOGY** is a leading authority on the latest developments in the aerospace industry. This week's special feature is a comprehensive report on the progress of the Apollo program, including details of the upcoming Apollo 11 mission. Other highlights include a detailed analysis of the challenges facing the space shuttle program, and a look at the latest advancements in satellite technology. The magazine also features a special section on the development of new aircraft designs, and a comprehensive guide to the latest in aerospace engineering. This is a must-read for anyone interested in the future of flight.

**Subscription Information:** One year (6 issues) for \$12.00. Two years (12 issues) for \$22.00. Single copies \$2.00. Payment in advance. Please allow 4-6 weeks for delivery. Write: Aviation Week & Space Technology, P.O. Box 990, Hightstown, N.J. 08520.

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take  
note:**



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And it's the only desk calculator in the world that does. The Friden SRQ Calculator.

To square a number, simply enter it on the keyboard, and touch one key. The answer appears in the upper display.

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These exclusive features, plus Friden fully automatic division and touch-one-key multiplication, free you for important tasks. The

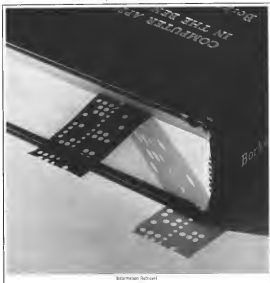
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portions have been created on several of these major projects. (These factors account, operations research accounts, systems-oriented engineers, and computer programming involved in processing this rapidly expanding technology are located in world libraries, California, SDC, 2412 California Avenue, Santa Monica, California. Facilities are open at SDC facilities in Santa Monica, Washington, D.C.; Lexington, Massachusetts; Fortran, New Jersey, and Dayton, Ohio. An SDC brochure on information retrieval also is available. Requests for the new brochure should be sent to Mr. Greenleaf at Santa Monica. "An open opportunity employee."

System Development Corporation



81 003

## AEROSPACE CALENDAR

(Continued from page 5)

- Sept. 9-12—International Conference on Test Methods for Electronic Research, Cambridge Institute of Technology and Wilbur Hall Hotel, Pittsburgh, Pa.
- Sept. 10-12—National Symposium on Space Rendezvous, Rescue and Recovery, Edwards AFB, Calif. Sponsors: American Astronautical Society, Air Force Flight Test Center.
- Sept. 10-12—New York University's Third Annual Air Transport Conference, Washington Square Center, New York, N. Y.
- Sept. 11-15—17th Annual National Convention of Aerospace Engineers Air Force Association, Shofar Park and Sheraton Hotel, Washington, D. C.
- Sept. 15-19—International Aviation Research and Development Symposium, Atlantic City, N. J. Sponsors: FAA.
- Sept. 18-19-1961—Aircraft Operations and Maintenance Symposium, Mitchell, N. J.
- Sept. 19-20—Third Annual Conference on Environmental Effects on Aircraft Systems, U.S. Naval Air Turbine Test Station, Trenton, N. J.
- Sept. 20-21-11th Annual Conference on Communications (Manufacturing), Institute of Electrical and Electronics Engineers, Hotel Rensselaer, Cedar Rapids, Iowa.
- Sept. 20-25—Ninth Annual Houston International Trade & Travel Fair, Sam Houston Convention Center, Houston, Tex.
- Sept. 22-25—Symposium on Available and Distance Modeling Technology, Williams House Hotel, Dayton, Ohio. Sponsors: Air Force Systems Command's Aeronautical Systems Div., AIAA.
- Sept. 22-27—National Aeronautics and Space Engineering and Manufacturing Meeting and Display, Society of Automotive Engineers, Anaheim Hotel, Los Angeles.
- Sept. 22-27—International Telemetry Conference, Savoy Place, London, England. Sponsors: Institution of Electrical Engineers (London), American Institute of Aeronautics and Astronautics, Institute of Electrical and Electronics Engineers, Instrument Society of America.
- Sept. 24-26-19th Annual Convention and Aircraft Show, National Business Aircraft Association, Sheraton-Hilton Hotel, Houston.
- Sept. 25-26—Second Annual Symposium on the Physics of Failure in Electronics, Chicago, Ill. Sponsors: Radio Air Development Center, Annual Research Foundation.
- Sept. 26-Oct. 1-14th Congress, International Astronautical Federation, Paris.
- Sept. 27-28—Society of Experimental Test Pilot's Society Annual Report to the Aerospace Engineers and Astronauts Association, Beverly Hills Hotel, Beverly Hills.
- Sept. 28-Oct. 1—Massachusetts International Exposition Meeting, American Institute of Aeronautics and Astronautics, California Motor Hotel, Palo Alto, Calif.
- Sept. 28-Oct. 2—Canadian Electronic Conference, Hotel du Rock and Sheraton, Expo, Exhibition Park, Toronto.
- Oct. 1-2—Eighteenth National Symposium on Space Electronics, Institute of Electrical

(Continued on page 9)

## NOW from DEI

Versatile ... Proven ... Modular

### VME/LNF Telemetry Receiver



- Video Amplifier Response DC to 1 mc with Impedance Selectable 75 or 600 ohms
- AFC Optional on all RF Heads
- Multiple Bandwidth Front Panel Switchable IF Amplifiers
- Multi-Range Deviation Meter Calibrated Directly in KC

Immediately available from Defense Electronics, Inc. is the versatile, helicopter, completely modular TMB-5A telemetry receiver.

This reliable unit will currently accept 16 plug-in tuning heads ... 14 plug-in IF strips and six demodulators ... any one of which can be easily removed from the receiver in seconds. Additional heads, demodulators and IF amplifiers are available upon request.

Plug-in RF heads can be instantly installed or removed from the receiver to provide the required frequency range by merely using the "slight-motion" pull out handle.

The video driver also can be readily converted by the various plug-in IF strips, ranging from 3 KC to 2.4 MC, and plug-in demodulators for FM, AM, PM and FM phase-locked applications.

This unit is particularly suitable for optical scan external tracking, dual diversity combining and predetection record/playback applications.

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## AEROSPACE CALENDAR

(Continued from page 7)

and Electronic Engineers, Pensacola Hotel, Miami Beach, Fla.

Oct. 13—National Aerospace Nuclear Safety Topical Meeting, American Nuclear Society, Albuquerque, N.M. Co-sponsors: Los Alamos Scientific Laboratory, AEC, Aerospace Operations Office, AF Special Weapons Group, AF Directorate of Nuclear Safety, Inada Corp., University of New Mexico.

Oct. 14—Symposium on Physics and New Structures, Trelong (London), San Antonio, Tex. Sponsored by Southwest Research Institute.

Oct. 14—National Assn. of Air Traffic Specialists, Sheraton Oklahoma Hotel, Oklahoma City, Okla.

Oct. 15—North Atlantic Communications Symposium, Institute of Electrical and Electronic Engineers, Hotel Utah, Umea.

Oct. 14-15—International Air Transport Assn. 79th Annual General Meeting, Rome, Italy.

Oct. 16-18th Annual Air Force Science and Engineering Symposium, Air Force Academy, Colo. Sponsors: Office of Aerospace Research, AFSC.

Oct. 18-19—National Airport Conference, Natick, Ohio. Sponsors: American Assn. of Airport Executives & University of Oklahoma with the cooperation of the Federal Aviation Agency.

Oct. 19-21st Annual Aerospace Electrical/Electronics Conference, Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 19-21—1968 General Conference, Fedration Aerospaciale Internationale, Mexico City.

Oct. 19-21—16th Annual Meeting and Conference, Airport, Germany. Council, Roosevelt Hotel, New Orleans, La.

Oct. 24-26—Flight Control Experiment and Symposium, Air Traffic Control Assn., Statler Hilton Hotel, Dallas, Tex.

Oct. 25-28—English Symposium on Ballistic Missile and Space Technology, Naval Training Center, San Diego, Calif. Sponsors: AF Space Systems Div., AF Ballistic Systems Div., Aerospace Corp.

Oct. 28-30—Tenth National Vacuum Symposium, American Vacuum Society, Statler Hilton Hotel, Boston, Mass.

Oct. 17-18, Oct. 21-22—North Atlantic American Conference, American Institute of Aeronautics and Astronautics-Canadian Aerodynamics and Space Institute Royal Astronomical Society, Manchester, in division of Technology, Cambridge, Mass. (Oct. 17-18) Queen Elizabeth Hotel, Montreal, Canada (Oct. 21-22).

Oct. 21-23—Tenth Annual East Coast Conference on Aerospace and Navigational Electronics, Institute of Electrical and Electronic Engineers, Eastern Hotel, Baltimore, Md.

Oct. 22-24—Conference on Expandable Structures, National Civil Institute Co's Sage Camp, Duran, Okla. Sponsors: Army Research Office-Durham, Aerospace Systems Division's Flight and Flight Operations Laboratories.

Oct. 25-26—International Symposium on Plasma Phenomena and Measurements, Institute of Electrical and Electronic Engineers, El Comte Hotel, San Diego, Calif.

**Hydraulic pressure control servo valve: for high flow with low pressure drop. Two stages. Modular design. Peak dynamic performance. Precisely built.**



This electrically actuated dual hydraulic pressure control valve is used in Hydras Air's famous Hydras Mark II valve control system. It facilitates the highly sensitive and continuous variation in brake pressures (from zero to full-system pressure) required by Hydras II, and it achieves this variation rapidly and without any action. It is a two-stage valve. The first stage (not shown) is a pilot-stage torque motor. The solenoid provides a pressure differential at the servo valve proportional to the current it receives and this differential pressure output is essentially independent of flow magnitude. The electro-magnetic portion of the first stage is isolated from the hydraulic fluid, eliminating the need for magnetic filtration. A replaceable cartridge filter acts as a secondary protection against contaminants. Here is just one example of precise and advanced hydraulic system components built by Hydras-Air. In substantial quantities. We are qualified for this work, we are equipped for it. Whether your need is for a pressure control servo valve—or for a complete electrohydraulic system that utilizes such valves—we'd like to hear from you.

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For details on MICRO SWITCH reliability control, write for the booklet, "Quality Assurance For Our Customers," or contact our Branch Office nearest you (See Yellow Pages).

"15M" Sub-miniature Switch shown above. Size: .35" x .50" x .38". Actings: 7 trips, 118 or 230 mc.; 4 trips 10d. and 7 amps. rms., 28 vdc.



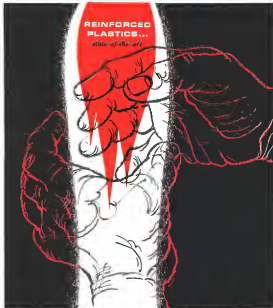
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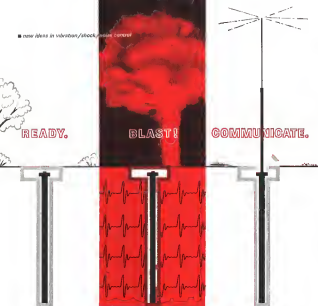
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Polled in underground sites, radio antennas are ready to pop-up for defensive post-attack communications to Titan III launch sites. But first, they must live through the attack. ■ Assuring survival is the job of special Lord shock mounting assemblies, engineered and produced for General Electric Company, systems contractor for Titan II communications. ■ Using both elastomeric mountings and steel springs, the system isolates the antenna from external blast effects. Antennae vertical, radial and torsional shocks. Supports full antenna weight. Resists radiation. Protects so well that conventional commercial-grade electronic components can be used. ■ What's your vibration, shock or noise problem? Give us a challenge — then expect more. Contact: Lord Manufacturing Co., Inc., P.O. Field Engineering Office is principal cities. In Canada: Railway & Power Engineering Corp., Ltd.



What new high speed tape transport means less down time?

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Here's how it's done. The highly stable, solid state servo requires less adjustment. Capstan rollers are quickly changed. Settings are quickly made. The head assembly is isolated. (This makes the tape path highly stable. In fact, dynamic skew at start time is less than dynamic skew continuous.) And precision, priceless reduction in skew. There's no tape flop; an erase head isn't needed. Positive safety interlocks eliminate tape damage. Instantaneous speed



variation has been reduced. Plus, up to 150 ips tape speeds. 2 ms maximum start time, 1.5 ms maximum stop time; 800 bps capability with or without clock track; available as a complete tape memory system with transfer rates up to 240 k/s. And above all, there's Ampex reliability and ruggedness throughout. The TM-5 is made by the Ampex Computer Products Co., Culver City, Calif. For information write Ampex Corp., Redwood City, Calif. Worldwide sales, service,



## Cubic offers first solid-state, 10-watt and 2-watt telemetry transmitters to meet full IRIG standards

Cubic's new Type IV Telemetry Transmitter is the first all solid-state, 2-watt airborne unit to meet all the standards established by the Inter-Range Instrumentation Group. Bagged construction is employed throughout, including use of a coating for the chassis and internal rf shielding. The Type IV measures 5" x 3 1/2" x 2 1/2", weighs only 26 oz., and is suitable for all attitude environments. It has been selected for use on a major satellite series.

Cubic Type IV is a crystal-controlled, frequency-modulated transmitter for the 225-300 mc range. It exhibits the low power drain and long life required for space vehicle applications. A Type V Transmitter, measuring 8" x 5 1/2" x 4 1/2" and weighing only 56 oz., is also available. It provides 10-watt output by means of additional stages of amplification.

These new telemetry transmitters are available for fast delivery. For more information, write to Dept. B-171, Cubic Corporation, San Diego 24, California.

**SPECIFICATIONS**  
**TYPE IV TELEMETRY TRANSMITTER**  
 Size: 5" x 3 1/2" x 2 1/2"  
 Weight: 26 oz.  
 Power output: 2-watts minimum  
 Power input: 6.5 amps max. 22 to 30 VDC  
 Deviation sensitivity: for 2V peak-to-peak input signal  $\pm 15000$  (Selectable  $\pm 6000$ ,  $\pm 3000$ )  
 Temperature:  $-50^{\circ}\text{F}$  to  $+155^{\circ}\text{F}$   
 Mod. Freq. Range: to 100000  
 Shock: 50G  
 Vibration: up to 15G at 2000 cps  
 Altitude: up to  $5 \times 10^{-4}$  in. Hg



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## Listen!

When the enemy strikes, nothing is so imperative as fast  
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multiplexer plays a vital role.

The AN/PCC-17 is used for the transmission of radar  
information, voice, teletype, digital voice, and all types of  
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tial in tactical missile control, fire control, and air-  
ground communications.

Lenkurt Electric was chosen to design this system to  
specifically meet the stringent requirements of universal military  
applications. The resultant system is a proprietary item of  
the U.S. Government—the only multiplexer of this type so  
designed. Capable of 100% data loading, and available in  
configurations up to 600 channels, the ultra-reliable, solid-  
state AN/PCC-17 can withstand the high shock levels of

hardened missile buses or transportation over unimproved  
terrain.

Although the system was designed to give superior per-  
formance over 6000-mile circuits, it has been proven over  
circuits of 15,000 miles. Already, there are more than 150  
fixed sites, shipborne, airborne and mobile installations  
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Lenkurt Electric Co., Inc., San Carlos, California. Other  
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**NEW!**

**BFGoodrich**

**Insulated wire undertread reduces cutting on BFG tires**

This is the new B.F. Goodrich "Cut-Protected" commercial aircraft tire for main wheel use. As the name implies, and tests have proved, the tire reduces curbside cutting and damage, and increases the number of times the curbside can be re-treaded. This significantly reduces tire cost per landing.

The "Cut-Protected" tire is built with shredded waste distributed through the underfoot. This inhibits cuts that do occur from growing, and damaging undertread and ply area. The shredded waste barrier is isolated from the tread by a double nylon shield. This stabilizes the tread rubber when

tires in under load and eliminates groove cracking.

The barrier shield also gives the undertread a simple visual reference when buffing. The re-treading operation is made more accurate and economical—and mistakes due to buffing too deep are eliminated.

This new tire incorporates the advanced design and compounding that goes into other B.F. Goodrich aircraft tires—selected tires offer life for the toughest

test jobs. For tires you can depend upon, contact BFG. Contact B.F. Goodrich Aerospace and Defense Products, a division of The B.F. Goodrich Company, Department A1F-4, Akron 18, Ohio.

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aerospace and defense products

## EDITORIAL

### Survival in the Space Age

*(National Aeronautics and Space Administration finding that public interest and congressional support for its programs are waning, has begun to emphasize the civilian uses of its technology in the national defense (see p. 32). Dr. Homer E. Newell, director of NASA's Office of Space Science, explained the importance of this procedure in the introductory lecture at an artificial satellite conference in Washington, Va., last week. Because of the growing interest and concern over the military aspects of space, NEWELL Wrote & Steve Tannenbaum is presenting a slightly edited excerpt from Dr. Newell's talk.)*

The entire world is conscious of the man-in-space program. The primary objective of such a program is to develop the capability of man to operate and do things in space, and . . . the means by which this is to be accomplished is to send men to the moon.

The Defense Dept. is working on applications of space to develop and maintain our military strength that we can never be forced wanting in any capability required to maintain our freedom and our safety. Also . . . the broad activity in space is undergirded by a program of advanced research in fundamental science and technology, carried out both in NASA and by the Defense Dept. to create our continuing capability to move forward along the most promising avenues of exploration, science, and application.

The outcome of this broad program, which occupies the early years of the space age will be of far-reaching consequences for our country and for the world. From the scientific and technological research will come precious additions to our stockpile of knowledge. As the frontiers of these technical and engineering research that fill the scene today, such knowledge is rightly esteemed in today's world. Among these technical and engineering research are space applications, both civilian and military, the significance of which can be immediately appreciated.

All of these are very important and valuable outcomes of our investment in space. But more important, far more important, is another outcome.

#### Significance of the Present

Out of this broad activity in space will come the ability of the United States to use space and to operate in space either as it now chooses to do voluntarily or as it may feel compelled to do in its own defense. The development of our ability to operate in space, including manned space flight given to our country, creates the means by which to meet the challenges—both opportunities and threats—of the future. We can do engineering in space, advance our science in a way that cannot be accomplished at the surface of the earth, and extend the range of practical applications for the benefit of man.

And, if necessary, we can thwart the attempts of any country to use space against us.

In this day and age we cannot afford to ignore this last point. In our own self-interest, and for the safety of our country, we cannot permit others to develop space capabilities that we cannot match, and that now, therefore, be used disadvantageously against us.

This is a capability we must have to ensure our survival in the space age as the independent, self-determining nation that our institutions set up to be and that we have always insisted on being.

This is the capability that we shall have from the development of the ability to investigate scientifically with satellites and space probes, from space exploration, from the ability to perform manned space flight and manned space operations, from the vast complex of manufacturing and assembly plants, launching complexes, tracking and telecommunication facilities, and from the irreplaceable experience that this initial stage in the space program will give us.

This is the most significant point about the present era in space. This is the most important aspect of the present activity in space.

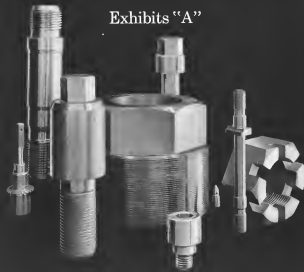
#### The Necessary Capability

We are now living the groundwork for whatever role we may have to play in space in the future. We are creating that no one will ever be in a position to use space against us while we, helpless and frustrated through lack of the necessary space capability, have to rely without reason.

In evaluating the space program, we must not lose sight of this broad aspect. It is this that gives the effort its meaning, and its compelling nature. The vast total of science, application, technology, manned flight through space, training of manpower, development, construction and operation of facilities, the strengthening of our military position in the world—which add up to our ability to choose our own destiny in space as we have done in earth—this gives to the space program its great value and importance to our total well-being.

Those who argue that we should concentrate with the fields of science and space exploration and concentrate on the necessities of military development forget that we can't really say what the military necessities in space will be. Our orbital ball is not that good, and it would be foolishly to pretend that it is. We do not wish to develop a Maginot line in space, only to have it thrust by waves of greater flexibility. We need to develop in broad very our space capability so that we shall have the ability to move in any direction required by future events to meet any threats along whatever lines they may develop. . .

## Exhibits "A"



... in evidence of the capability SPS offers you in hyper-precision threaded parts. This is hardware as a pair with clean-room stuff. This is hardware made under the most exacting controls practiced in the nuclear/military art today. Name your material—Inconel, Haynes, titanium, beryllium, moly, columbium, tungsten. Name your thread diameter—through 17 in., for example. Name your most stringent specs. SPS can meet them. And SPS can document the quality of every part it produces for you. This is capability not come by overnight. It derives from years of setting increasingly tighter standards in precision fastening—for general industry, aviation, electronics, space. Contact STANDARD PRESSION STEEL CO., Precision Machined Parts Sales, Jenkintown 33, Pennsylvania (215-884-7300) • Santa Ana, California (714-545-9331).

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## WHO'S WHERE

### In the Front Office

**Dr. Clark McIlroy**, Director of the Goddard Space Administration Laboratory at the California Institute of Technology, elected a director of Aeronautics General Corp. Aeronautics General Corp. is a subsidiary of the Goddard Space Administration, Washington, D.C.

**Marvin F. Bell**, president of Norton Instrument Co. and Space Systems, Inc., Los Angeles, Calif., succeeding Robert Novak, president of Norton Instrument Co.

**Robert J. Benson**, president, Western Corp., Los Angeles, Calif., succeeding Thomas J. Benson, who continues as chairman.

**Dr. Harold M. DeGroot**, president, Millwright Applied Systems Corp., West Lafayette, Ind. Dr. DeGroot has been granted two years' leave of absence as head of the Goddard Space Administration and Executive Science.

**Thomas J. Sullivan**, president and head of the Goddard Space Administration Laboratory at the Goddard Space Administration, Los Angeles, Calif., succeeding William W. Douglas, Jr., who has joined Thermo Chemical Corp.

**J. Frank Pratt**, president, Princeton Instrument Corp., Princeton, N.Y., a subsidiary of GTE, Inc., General Precision Associates Corp.

**M. E. Korte**, vice president, General Radio Corporation of America, New York, N.Y., and Stephen S. Benson, division vice president, General Radio Corporation of America, New York, N.Y.

**Executive Vice President** General Radio Corporation of America, New York, N.Y., and Stephen S. Benson, division vice president, General Radio Corporation of America, New York, N.Y.

**Frank D. Longmire**, a vice president, Hughes Electronics Corp., Los Angeles, Calif., responsible for marketing.

**James de Munn and Eugene V. Korte**, vice president, Hughes Electronics Corp., Los Angeles, Calif., responsible for marketing.

**Dr. Kenneth G. Chubb**, vice president, Space Research and Systems Div., American Science and Engineering, Inc., Cambridge, Mass.

**Mark Rowe**, executive vice president, Capital Systems, Inc., and Ben Taylor, vice president, Capital Systems, Inc.

**Kenneth M. Carpenter**, executive vice president, Millwright Applied Systems Corp., West Lafayette, Ind.

**Capt. Donald C. Chubb**, USAF, vice president, Space Research and Systems Div., American Science and Engineering, Inc., Cambridge, Mass.

**John E. B. Bell**, retired.

**Honors and Elections**

**Walter Kilde** & Company, Inc., has been awarded the 1965 Aeronautics General Corp. Trophy for outstanding contributions to system sales.

The Millwright Applied Systems Corp. (MATSI) has been awarded the Tullberg Trophy for excellence of permanent membership in the front.

(Continued on page 118)

## INDUSTRY OBSERVER

**First** in-flight shutdown of the Post & Whitney liquid hydrogen fueled engines in the National Aeronautics and Space Administration General Dynamics/Astronautics Centaur upper stage may be attempted on the fourth Atlas Centaur custom Second Centaur vehicle, now scheduled to fly late in September or early in October, will carry about 599 submergence missiles, chiefly for monitoring acceleration forces and the guidance and control system. Second Centaur is being piggybacked to base for about 180 sec.

**Progress** in developing techniques for determining the attitude of a passive satellite by means of signals bounced off the satellite from a ground station is planned by Rome Air Development Center, RADC, is showing qualified sources for the program, which is identified as A-46.

**An** French Ballistic System Div. is considering plans for a two-stage solid-propellant rocket approximately 115 in. in diameter and capable of being deployed in existing Minuteman silos. Payloads anticipated for the booster may range as high as 100 tons.

**An** extremely sensitive piezoelectric transducer, originally designed as a seismic ground detector, has successfully detected the first heartbeat of a chicken embryo—the first time this has been done without inserting probes into the egg. The device is expected to have widespread application in the space sciences, where a rugged, highly sensitive and extremely accurate sensor is required. The transducer was developed by Vazara Kaggle, leader of Vazara Kaggle who invented the Kaggle sensor.

**First** flight of the Long-Term Vehicle (LTV) X-10A, a two-stage transonic prototype, has slipped from next March to next July, because contract increments have required schedule to be held in a minimum in order to use within the funding available. LTV has completed and received all engineering drawings in the shop, 80% of the tooling has been completed and about 40% of the detail parts have been fabricated. Item, a team member with failure on the X-10A, has completed the first wing, and tests and feedback are taking shape as assembly gets at LTV. Hamilton Standard completed a 10 lb. test on the tail motor just over a few days.

**Progress** definition phase reports on a multi-connection satellite system, submitted last week to USAF's Space Systems Div. by General Electric and the team of Perkin and Space Technology Laboratories, both divisions would be a two-stage satellite system, which is scheduled to be about 1,000 lb. Satellite generally will not carry dual equipment for standby service, although PMA has proposed use of two traveling-wave output tubes because it is the least-powered element (AW Jan 26, p. 13).

**High** performance Roll III-1B (AW Dec 10, p. 21), which now has completed development, is expected to be completed in 1965, on either side of the cubes in best performance into the 1965-1966 program, is expected to begin the process of an evaluation program for the Air Force, late next month. Modification is being performed by the Swanton Corp., San Antonio, Tex.

**USAF/Martin** Titan 2 scheduled to fly from Cape Canaveral late last week, was to test the suborbital delivery system authorized for the Titan 2 that will launch the new NASA Gemini capsule. Titan 2 has been the Air Force's main launch vehicle for more than two years while USAF and NASA attempted to work out an integrated plan for testing various Gemini launch vehicle configurations on the next model launching in USAF's flight test series.

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AVIATION WEEK & SPACE TECHNOLOGY, August 19, 1965

## Corrosion at high pressures?

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## Research Dilemma

## Washington Roundup

Congress is groping for a way to control the deluge of tax dollars being spent on modern science but the old traditions of seniority and committee prerogatives keep getting in the way.

Senators and representatives, especially the younger ones, are reacting to guilty consciences about the high-minded way Congress approves research funds and are demanding new legislative machinery.

One group of representatives is passing for a special five-member committee, to be appointed by the House speaker, which would take a broad look at federal research say 1% to coordinate it and find soft spots. Rep. Carl Albert, sponsor of the committee to establish the special committee, credits the \$149 billion the government plans to spend on research this fiscal year "to not necessarily changing" but "we must make ourselves more hands-on and more watchful."

Chairman Carl Albert of the House Armed Services Committee and George P. Miller of the House space committee declare they already have the job and are taking it seriously. Rep. Vinton had work cleaned the special committee would lead to the kind of duplication Congress fears reliving the executive branch to eliminate. Chairman Carl Albert of the House Military Operations Subcommittee and finally that no few representatives, regardless of the size of their staff, could even begin to understand, let alone evaluate, the total federal research effort. But behind the machine must Congress must make a try.

## Senate Proposal

Sen. E. L. Bennett last week introduced a bill to create a Congressional Office of Science and Technology (COST) composed of what he called "scientific generalists" to advise congressional committees. He says COST is a clearing house where committees could obtain expert guidance. Now, he said, "Congress has no source of independent scientific wisdom and advice. For too often congressional committees for expert advice rely upon the testimony of the very scientists who have conceived the projects, the very scientists who will spend the money."

This groundswell of concern will at the least spur existing congressional committees to protect their jurisdictions by taking a closer look at research money requests and may well lead to some new legislative machinery. In short, research money is going to be harder to get from Congress from now on.

Chairman Richard B. Russell of the Senate Defense Appropriations Subcommittee intends to get the Fiscal 1964 military budget bill moving this week by holding fast reform hearings—no more than two days on the hot spot before studying the measure for the floor.

## Solids' Future Gloomy

Administration has all but decided to cancel or stretch out development of 156in. and 260 in. solid rockets and rely entirely on liquid-fueled boosters through 1964 and 1965. This economy move will not affect development of the 120in solid strapon booster for Titan 3. Chairman George P. Miller of California, where three of the four largest solid rocket plants are concentrated, will press the NASA to take over the solids program if DOD cancels it (AW Aug. 5, p. 25).

## SSD Dyna-Sour Role

Responsibility for flight testing the X-28 (Dyna-Sour) will be transferred next month from the Aeronautical Systems Div. project office at Wright-Patterson AFB to the Space Systems Div. at Langford, Calif. ASD still will define test objectives.

Since SSD had performed Blue Gemini in a winged vehicle, the transfer is seen as an attempt to unify USAF space enthusiasts behind the Dyna-Sour program and perhaps loosen chains of its coordination. Systems Command has transferred the X-28 from its existing Electronic Systems Div. to its strategic communications and tracking group.

Plans call for SSD to conduct both air-drop and booster launch tests of the X-28, taking over the pilot training job from Edwards AFB.

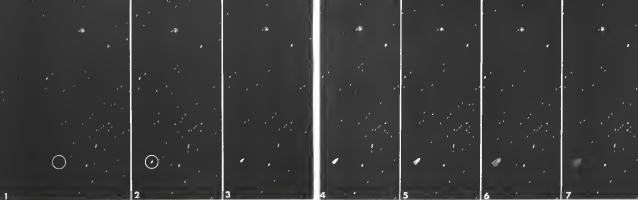
J. Kenneth Callahan, former ambassador to India, will go to Ottawa this week to represent President Kennedy in the effort to resolve U. S.-Canadian relation problems (AW June 1, p. 54), principally Canada's demand for more U. S. traffic rights for Trans-Canada Airlines.

Management of NASA's Marshall Space Flight Center is being reorganized through the appointment of William B. Young, vice president and managing director of Aerojet-General's Sacramento plant, as director of projects and vehicle operations. Starting Nov. 1, Young will supervise contractors working on the Saturn 1, IB and 5 vehicles. He also will oversee work at NASA's Marshall plant and Mississippi Test Facility.

Washington Staff







## South African Station's Photo Sequence

Firing of the Syncom communications satellite 1,000-ft thrust apogee motor, photographed at a South African tracking station at 3:06 p.m. EST July 26, produced a plume in space over 80 mi. long and 30 mi. wide in less than 1 sec. The station at Observatory, South Africa, one of 12 in a worldwide network operated by the South African Astronomical Observatory under a National Aeronautics and Space Administration grant—photographed the firing with a Bolex Narm camera with a 35-mm. focal length at f11. Exposure time for each frame was 1/500 sec. Just after ignition, in photo No. 2, the firing is still only a dot (circled on the negative) but subsides 1 sec. and on as a cloud

## Shows Firing of Syncom's Apogee Motor

19 mi. The motor burned 15.9 sec., and at the time of burnout (photo No. 7), the plume was 65 mi. long and 33 mi. wide. In the final photo here, No. 7, the dimensions had reached 92 mi. in length and 66 mi. wide. The satellite is traveling east-southeast at the apogee. Firing of the solid-propellant apogee motor, a Jet Propulsion Laboratory development, took place 6 hr. after launch at an altitude of 12,140 mi. (JAW Aug. 5, p. 7). Late last week NASA paid the satellite's citizenship (its 2,024 hours over a 15 mos., 24-sec. period is an attempt to halt spacecraft drift and stabilize the satellite over 15 deg. West longitude. Initial data indicated the attempt was successful.

## Space Council to Check DOD Range Plans

Washington—Close examination of Defense Dept. plans for increasing the size of its global space communications and tracking networks to use of the duplicate civilian space agencies plan will begin next month as new draft fiscal 1965 budget proposals reach highest Administration levels.

Acting for the President and the Budget Bureau, the National Aeronautics and Space Council will take a hard look at defense plans for range expansion.

The first move under these plans would be to consolidate management of the three national missile ranges. A preliminary study of the consolidation is now being conducted here by USAF Maj Gen Leighlin J. Davis, commander of the Air Force-operated Airborne Missile Range.

There are legitimate reasons for Defense Dept. to operate range and tracking facilities separate from those of the

National Aeronautics and Space Administration according to a high Administration official, because all classified projects whose secrets must be protected. But it is typical of military planners to overstate their requirements, he said.

Detection of these excess requirements so that duplication can be held to a minimum will be the job of the council.

The Air Force, as the principal Defense Dept. agent for military space research, development and operations, now believes it has a valid case to present to the director of defense research and engineering for single-manage operation of the Atlantic range, the Pacific Missile Range and the White Sands Missile Range.

The Pacific range is now operated by the Navy and the White Sands range by the Army. As of late last week, neither the Navy nor the Army had

been officially asked for their reactions to the proposed consolidation. A Navy official said he would either use the Pacific range management remains undisturbed but would either use to having it placed as a whole under a single management. Army reaction was the same.

The Navy developed the Pacific range, with headquarters at Pt. Mugu, Calif., to test submarines, ship and aircraft launched missiles and to provide training for the crews.

The range then grew to accommodate tests of operational configurations of Air Force intercontinental ballistic missiles as did at Bikini Atoll and tests of the Army's Nike Zeus antihallucinate missile system.

To divorce these added facilities now from the Navy's missile range would be unwarranted and expensive, the Navy insists.

The Air Force was encouraged to make the consolidation study. So, the

director of defense research and engineering. The single-manager proposal will have to be discussed with NASA officials, however, since NASA requires launch for the Gemini two-man orbital rendezvous mission with an Agena vehicle, will require expanded control and communications facilities around the globe. The Apollo moon landing program will require further expansion and changes.

NASA has indicated that as long as the defense controlled networks are made adaptable to its needs, it will have no objection to consolidated management.

A single-manage military system might even ease interface problems on NASA spacecraft and.

Entering into this is all space range picture is a basic difference between the Defense Dept. and NASA in recovery sites. The Air Force has proposed a triangle of land recovery sites between Edwards AFB, Calif., Westcott Utah and Holloman AFB, N. M. NASA, however, may face weight prob-

lems with later Gemini flights that would necessitate launching the capsules at low angles to the equator to take advantage of the earth's rotation for added velocity.

That limits the latitude for recovery and makes the area near Houston, Texas, more desirable.

### CH-53A Avionics Winners

Washington, September 26—Of two shops the Teledyne Systems Corp. and Texas Instruments have been selected by the Navy to conduct a three-month program definition phase aimed at development of an integrated avionics system for use on the Sikorsky CH-53A heavy assault helicopter by the Marine Corps (JAW June 24 p. 116). The major new avionics program will explore a new approach to design of a control digital computer as which analog-digital sensors and mission planning elements are built into the sensor elements rather than the computer itself.

NASA also may have proposed requirements for use of West Coast launching sites. Air Force experts to launch the Titan II booster from either Vandenberg AFB or Pt. Arguello for some reason. Early info, made use of PDR facilities. Pt. Arguello is, Navy controlled. NASA also may want to launch Titan II from sea, or the other site eventually.

The Davis study will propose that Vandenberg AFB be turned over to the Air Force Systems Command. It is now under control of the Strategic Air Command because its principal use is for firing of operational ballistic missiles and crew training.

SAC is objecting, however, because it maintains that other space systems are developed by Systems Command and become operational, they will come under its control.

Strategic Command maintains that an military increased space flight development progress during the next few years it should have control of Vandenberg AFB.





ALPHABETICAL LISTING OF ISSUES: 1993-2008

working in its effectiveness because as new carriers have replaced old ones. The older Essex class carriers operate against that as less effective.

Defense Dept. delayed construction of heavy attack carriers (CVAs) number 67 and 68 until the Navy had a better understanding of the need for the new class of ships. The delay was not the result of determining whether or not it should be nuclear or conventionally powered. Delivering a budget report for CVA-67 and CVA-68 would result in further substantial savings. The entire package for a new carrier, including aircraft, personnel, training, ship cost and equipment amounts to more than \$600 million.

Further savings could be made by shifting out or away Essex class carriers to ASW duties and reforming an older ASW carrier. However, only about \$100 million savings per year would be realized for each one because the rational costs have been written off for both the ship and aircraft.

#### Force Characteristics

Defense officials argue that force characteristics are bound to change with time. These changes now are coming about in all three military services. The Navy's new force characteristics are being developed in a way that will be different from the old ones. The changes will be made in a way that will be different from the old ones.

These officials see the reduction of the nuclear carrier fleet, the shift to smaller and the leveling off of the nuclear program as examples of changing character of forces. The Navy budget, which increased more in proportion to the other services in the last three years with the advent of nuclear-powered submarines and missile launching submarines, now has a cut. The Navy still is being given the money to make the adjustments. If it fails, the changes will be made anyway, by McNamara.

Here is the breakdown of the Navy's 1974 force characteristics:

- **Enterprise.** This is the largest carrier ship in the world. It is 1,031 ft. long and displaces 90,000 tons. It is powered by eight nuclear reactors. It cost about \$500 million to build, even though it is a small missile submarine. It was eliminated. Future nuclear power carriers would be powered by four reactors, making them slightly smaller and less expensive. Navy believes the reduced cost would give congressional critics.
- **Forrestal class.** These carriers, displacing 70,000 tons each, are carriers that are powered by one reactor. The most advanced version, the USS Zumwalt, is being built. It is the class of the Independence, Kearsarge, Saratoga, Constitution and Kitty Hawk. They have proved the test in the last few years.
- **Midway class.** These ships, 44,000-

ton carriers were designed during World War II and are being replaced by the new ones. They were the first carriers to have missile decks. In addition to the Midway, the Forrestal D. Roosevelt and the Constellation have angled decks and missile launchers. They are being replaced by the new ones. They are being replaced by the new ones.

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## Defense Profits Will Be Linked To Contractors' Performance

Washington-Profit resulting from contract work will be linked to contractors' performance in the future will be tied to contractor performance, not to the amount of private investment in property, equipment and personnel. The new Defense Department Regulation (ASPR) which became effective last month, says that the amount of profit for a contractor will be based on the amount of private investment in property, equipment and personnel. The new Defense Department Regulation (ASPR) which became effective last month, says that the amount of profit for a contractor will be based on the amount of private investment in property, equipment and personnel.

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## Kennedy Names Black as Advisor On Supersonic Transport Program

Washington-President Kennedy last week named former World Bank Director Eugene B. Black as special advisor on the development of a U.S. supersonic transport program. At the same time, Federal Aviation Agency sent requests for proposals to reform and engine manufacturers for a supersonic transport design which is being built by the Boeing Co. and the Lockheed Corp. The program is being built by the Boeing Co. and the Lockheed Corp. The program is being built by the Boeing Co. and the Lockheed Corp.

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## News Digest

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# CAB Urges Local Service Subsidy Cuts

Report to White House proposes one-third reduction in five years; carriers' size ambitions are criticized.

By Robert H. Cook

Washington—Reduction of the local service subsidy bill is at least one third over the next five years was recommended last week by the Civil Aeronautics Board in a highly critical analysis of the industry presented to the White House. The subsidies are now running more than \$60 billion a year.

Most thrust of the report, prepared in compliance with President Kennedy's transportation message to Congress last year, is that while the industry has done a good job in controlling costs, its rising subsidy bill reflects the ambitions of many local to achieve "breakfast tables" rather than maintain their status as "gray coats" operators.

Secretary of Commerce Luther Hodges was urged by the President to hold a special conference, composed of representatives of the Federal Aviation Agency, the Bureau of the Budget, and the Council of Economic Advisors, which will review the report and make recommendations for any necessary administrative or legislative action.

The report put the industry on notice that CAB feels the time has come for the local service subsidy and the government to "reduce the fruits of government" and consider subsidies. Subsidy needs should now begin to decrease as traffic grows to fill the expanded capacity created by Board approval of route extensions and nonstop services. The report put the industry on notice that CAB feels the time has come for the local service subsidy and the government to "reduce the fruits of government" and consider subsidies.

## Report Critical

At the same time, the report said much of the industry's flight is equipment program for flying to meet actual needs of the airline routes and producing savings that would lead to a subsidy reduction. The venerable DCA-3, which still provides such, held the local airline industry, still remains the most consistent subsidy support, and there is little chance that it will be reduced within the next five years.

The Board continued to continue to cooperate in industry's attempts to find a DCA-3 replacement, but refused to halt the subsidy reduction plan while the search goes on. Although the new modern routes organic aircraft are being used by the local service airlines provide increased speed and capacity, which is heavily subsidized on the industry's short haul routes, the report urged any move by the industry to expand this problem by offering faster and larger jet equipment.

percent 42.35 average to about 40% and by "inclusion" requirement, placing capacity caps where needed. The added expense of handling this new traffic should require only one half of the additional revenue, the report said.

•Flight frequency, or capacity, was singled out for particular scrutiny. By the Board, which gave clear notice that it intends to search hard its subsidy support of frequency.

While there is a "reasonable need" of the local service subsidy, the Board said, it is not a "blank check" and it is not a "guarantee" of the local service subsidy. The Board said, it is not a "blank check" and it is not a "guarantee" of the local service subsidy. The Board said, it is not a "blank check" and it is not a "guarantee" of the local service subsidy.

Stating of \$125 million in total subsidies over the five year period could be reduced, the report said that Board believes for additional subsidy in some cases, plus a provision for given services would drop this figure to \$64.5 million. Other subsidy reduction plans, in the helicopter, Hawaiian and Alaska operations, could bring the total savings for the five years back up to \$74.4 million.

The net subsidy reduction for the five year period would be \$5.5 million for the first year and about \$15.7 million by the end of the fifth year. The central reduction of helicopter subsidy by \$2 million, the Hawaiian subsidy by \$20,000, and of the Alaska subsidy, to \$3.7 million would drop the industry's aggregate subsidy cut by \$24.5 million at the end of five years.

Looking heavily on an expected continuation of traffic growth, the Board's report is based upon these major premises:

- Local service growth rate has been average 1% during the past five years. If applied to 1962 passenger air revenues of \$338 million would be the current, this would produce added gross revenues of \$3.5 million during the first year of the subsidy reduction period and \$39 million by the fifth year. Last figures in the period can be expected to rise from this

- CAB currently faces about 120 cost estimates as input to the "use it or lose it" regulation and expects that nearly one third of these items which fail to generate less than five passengers a day will be eliminated from the local service system. Subsidy saving here would be about \$1 million a year, or \$2 million during the five-year subsidy plan.

- Consolidation of airline services at two or more cities into one city and one airport is a major point of the reduction schedule. CAB estimates that local service revenue can be transferred from 67 airports, 23 of which may be affected by the "use it or lose it" provisions. Of the remaining 44, 30 can be eliminated in the DCA-3 in the next two years and the balance in the last three years. Cost studies indicate a net annual subsidy saving of more than \$30,000 per airport. Total subsidy saving in the five-year span would approximate \$650 million.

## Board Drafts

The Board complemented the industry on showing the increased cost of operations without causing the loss of its product, but expressed doubt whether the local operation could continue to do so. By the third year of the subsidy reduction program, and even of the current year increase in such a 2% effort, this subsidy could be reduced to 75% of its current level by the airline industry and 25% by subsidy.

If this happens, the report said, the extra subsidy required would amount to \$1 million in the third year, \$1 million in the fourth and \$3 million in the fifth year.

Industry broke in having replaced more than half of its DCA-3 fleet with faster and larger equipment and its

hoping to acquire even more sophisticated equipment, were questioned closely by the report.

Noting that the speed and capacity of many more airlines would be of little value to the local service airline, the report expressed doubt that the industry will find any replacement more economical than the DCA-3 in the next two years. Two airlines, companies between aircraft types are made without incurring depreciation or by including this expense without allowing for the effect of a return on investment and its diversion. As an example, the report cited one aircraft with a before depreciation plane value of \$100,000 per year less than the DCA-3. The addition of depreciation cost, however an investment, and two aircrafts finally raised the complete plane value cost to \$100,000 more than that of the DCA-3. To offset this increase, the most modern aircraft would require 10% more passengers than the DCA-3, CAB said.

The report further said that while the Board is pleased with the past local service airline and similar manufacturers, it is not sure that the DCA-3, then does not need a new airfield replacement on hand or under development. CAB will continue to cooperate in the search for a satisfactory replacement but will continue to push for more of the possibly available requirements which have operating economies effect by depreciation and return on investment expenses.

## Family Fare Plan Producing Shift To First Class as Traffic Climbs

Washington—U. S. domestic traffic has now reported to show a 10% traffic increase for 1963 but a trend to reduce the lower fare levels, although in a causing a new demand for first-class seats—would present a corresponding rise in revenues.

Comparative figures for the two months are not yet available, since Eastern Air Lines suspended operations between June 21 and July 22 last year as a result of a flight engineers' strike. Service was restored on a gradual basis, but the airline's first-class ticket can take its toll and members of its last half of the first-class cabin, being less than the cost of an equal number of second-class seats.

While the airline plan has helped fill the first-class section it has induced overall value, thus indicating that the lowest traffic flow is now at the lowest fare structure. In effect, the airlines, which have wanted to narrow the gap between first-class and tourist fares, by raising tourist fares, are reducing their losses by cutting first-class sales. Traffic on the family plan are producing less profit than are tourist passengers.

and industry desired their promised to use the tourist plan on jet flights.

The family plan, now in effect on many airlines, has been a success, though in a causing a new demand for first-class seats—would present a corresponding rise in revenues.

The month covered by the family plan was reflected in July by a decline in

coach or tourist load factors. For example, American Airlines reported a jump from 45% to 57% in first-class load factors and a decline in coach load factors from 64% to 63%. Load factors reported by United Air Lines for July showed an eight-point increase in first-class load factors and a six-point drop in coach load factors.

The trend is visible throughout the industry. It is too early to determine whether the family plan is causing traffic from the coach section to a still lower, non-producing category of travel without attracting new traffic into airline transportation to offset the reduced value. If this is occurring, it is possible that an airline's driving force may be lost and the industry in recession without opening new markets in United countries—then give reason for the year will be depressed.

If the trend continues, airlines will be required to increase the number of first-class seats, which has remained fairly constant for the past few years. Such a change in seating configuration would reduce the total revenue and increase the cost. This, in turn, would reduce load factors without giving any appreciable strength to revenues.

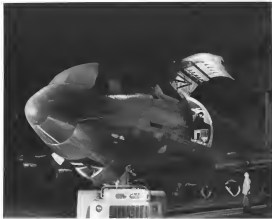
## Traffic Rise

Meanwhile, there are no signs that coach business is beginning to suffer as a result of the diversion to first-class. In fact, coach traffic rose 23% against a 19% increase in total traffic in the second quarter of 1963, particularly the 50% discount to maintain passenger traveling on foreign, and domestic routes are showing a decline in the volume of traffic, which has averaged 10% in a low yield per seat rate. If such traffic is filling seats that might otherwise be empty, the airlines gain. If it is regular traffic, however, the volume of lower fares will be depressed.

Total revenue passenger miles for the industry increased 22% in July and 16% in June, compared with the same months last year. Assuming that first-class load factors are around 60% during these two months in 1962, it can safely be estimated that traffic volume would have been about 11% in July and about 4% in June of the year compared with these 1962 figures.

There are reasons, given in view of the average 7% monthly increase in passenger air traffic for the month of 1963. In addition, the airlines load factor for June is the highest monthly level reached since June 1961.

In June, average passenger miles passed the 3 billion mark for the first time in airline history. Available seat miles also hit new peaks in June and July.



**JET AIR PRESENTER.** New Boeing cargo jet, now in service, makes the Airline a major cost. Distribution system built around jet air freight results in major savings in inventory, warehousing, routing and ground handling expenses—that overall cost is reduced. Deliveries in hours instead of weeks.

improve competitive sales position and speed capital turnover. Boeing cargo jets carry higher payloads at lower transport costs than any other commercial transport. Now flying with Pan American, Northwest Orient and World Airways, Boeing cargo jets enter another team with American, TWA and Jetair Airlines.

## Capability has many faces at Boeing



**MICROMINIATURE.** This tiny computer search is one of many advanced areas of Boeing electronic aviation, which produces electronic systems for aircraft engines and space vehicles.



**BATURN V.** Boeing, which will build 100 in 1980, is one of many advanced areas of Boeing electronic aviation, which produces electronic systems for aircraft engines and space vehicles.



**U.S. AIR FORCE** vehicles, using Boeing engine recovery system, enabled 24-hour tactical rescue flight with only two day support. Boeing rescue engine recovery system proved vital, controls, critical docking and life support systems.



**BOEING** Space Technology Resources: Boeing Defense, Aeronautics, Space Division; Boeing Commercial Airplane Division; Boeing Aerospace Division; Boeing Defense, Aeronautics, Space Division.

# American, TWA to Swap Engine Overhaul

New York-American Airlines and Trans World Airlines have reached a reciprocal agreement on engine overhaul that extends to night flight equipment a trend that began with joint parts inventory programs and ground handling equipment.

TWA will overhaul Pratt & Whitney JTSD turbofan engines for American's 27 Boeing 727 three-engine transports on order as well as its own 727 engines, at its Kansas City overhaul base.

American, in turn, will overhaul General Electric CFM56-3 engines powering TWA's 26 Conquest 550s at its Tulsa overhaul base. Turbofan CFM56-3 engines for American's Conquest 990s are being overhauled in Tulsa, too.

Overhaul engine packages will be waiting at each point for certification. General Electric (TSD) will go back into American airplanes and TWA JTSDs into TWA airplanes, but provision is made for limited pooling.

American will be overhauling more TWA engines than TWA will overhaul American (TSDs, but the CFM56 has a TBO limit of 1,200 hr. Time between overhauls has not been established for the JTSD but it is expected to begin at 1,000 to 1,200 hr).

Each airline will bill the other for work performed on less worked out to equalize.

To help equalize work loads further, American will only overhaul the bare engine for TWA, but TWA will get the engine engine and accessories from American.

The reciprocal feature does not extend to a pattern for further agreements, since opportunities for such equal exchanges are limited. However, TWA is seeking additional JTSD overhaul work from airlines adhering the 727 or the Douglas DC-6.

American overhauls CFM56-3B and JT8D engines powering a Federal Aviation Agency Conquest 550 and 990 respectively.

American signals the plan as an interim demonstration of the concept of a work-out to successfully as the two firms expect.

Smaller airlines should find the inventory savings gained in overhauling for their overhaul capacity spending. Work between.

Previous efforts of this kind, such as American's system in which Allison Div. of General Motors handed out half of American's Electro engines, did not meet expectations. What now has been the mutual element is that each work must be handled by either people for release people.

Another mutual element is the cost factor. No members are involved in the agreement. Other than a few known personnel, no American employees will be based at Kansas City and no TWA employees at Tulsa. Each airline is relying on the other to perform the work on exchange engines as if they were that own. The agreement does provide for exchange of assets, insurance, and complete engine performance and overhaul records.

TWA will maintain its 530 engine at Kansas City, ship the power package down to the base engine at the overhaul base, and track it to Tulsa for overhaul. American will do the same with its 727 engines at Tulsa.

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## Court Upholds Allied Pilots Pact

New York—Sight of the Allied Pilots Association to break away from the Air Line Pilots Union and sign its own contract with American Airlines was upheld last in a federal district court decision last week.

Judge Isaac B. Weitz of the Southern District Court of New York ruled against ALPA's that union's not which sought to replace American from signing the contract with Allied. ALPA contended that it, not Allied, was the recognized bargaining agent for American's pilots.

Heinz Wenz, counsel for ALPA, has appealed the decision. A hearing on the appeal will be held Sept. 3 before a three-judge panel in the Second Circuit U.S. Court of Appeals here.

To give the ALPA national representation, controlled by employees of other airlines, a vote power over contracts negotiated by the American pilots, who most work under the contract, it not consistent with democratic procedure," Judge Weitz said.

American's 727s. Some exceptions are provided, however, in cases where specific capabilities are required. American will handle turbo-propeller overhaul for TWA, and it will also continue to handle its own constant-speed drive work for the JTSD, since this unit will be primarily installed with American's Boeing 707-series airplanes.

TWA 727 engines will not go to Tulsa until February to permit as readily allow out of the country with GE. TWA will begin engine at American's JTSD engine operation eventually with support planning and actual processing. American 727s will start service next spring.

During the first year of the five-year agreement, American will do twice the engine work for TWA than TWA will do for American. American's work load will be about the second year, but will be about the first year the work loads will balance.

American will add about 70 employees at Tulsa to handle extra work during the early phase of the agreement. Overhaul effort will be in American employment at both bases, rather than increase or decrease it.

R. M. Davis, TWA vice president for technical services and its only advisor of space pooling, negotiated the agreement for TWA. Discussions with Wenz for American had begun more than a year ago, but final action on the plan was stalled by American's reluctance to accept with Eastern Air Lines.

However, Judge Weitz issued a companion decision upholding a suit brought by the Flight Engineers International Union which establishes that union's right to represent American's flight engineers.

Shortly after Judge Weitz's decision, Adair Schwartz, counsel for the flight engineers, presented the union's own suit designed to attract the union. The conditions include a training program costing \$10 million for the engineers to obtain their commercial and instrument pilot ratings.

American has and reportedly that it will not pay for such training. But the engineers consider the pilot rating as a point, particularly since other carriers, such as Trans World Airlines and Eastern Air Lines, have agreed to pay such costs and the FEAs insist all its members equally qualified.

American's engineers also want their contract to contain their permanent right to the engineer's seat, a job security provision.



## BAC 111 Maiden Flight Scheduled

First British Aircraft Corp. BAC 111 two-eng, turboprop transport, scheduled to make its first flight this week at Wickham/Avington, Herts, England, last assembly plant, carries 6500 lb. of flight test equipment and carries Auxiliary Landing system. The aircraft is painted in British United Airways livery but is owned by BAC. First BUA airplane is No. 2 on the line and will be rolled out in five weeks. Engine repairs on the Rolls-Royce Type 1 powerplants were being completed last week, with only minor runway adjustments being made. First batch of BUA aircraft will use the 1, which produces 19,000 lb. thrust. Later aircraft will use the 2 version, producing 16,400 lb.



## This Week Following Engine Tests

First BAC 111s for American Airlines will have the more powerful Type 2 engines (AV. July 22, p. 25), now under development in collaboration with British government and Rolls-Royce has completed some 150 h. test runs to meet the Washington Board Federal Aviation Agency specifications. First view (top left page) shows close wing detail and inlet for 10,000-cu-in. per min. ram mounted in tail cone. Unit provides power for main engine starting, ground electrical power and ground cooling of cockpit and passenger cabin. For additional photos, see p. 45.





## Which exhaust valve is the real bargain?

The exhaust valve on the right was sold at economy prices as a new part for Pratt & Whitney Aircraft's R-2800 engine.

Superficially, it resembles the genuine Pratt & Whitney Aircraft original equipment part at left. But laboratory tests show that it has been re-worked. The stem tip has been replaced with material which is less than half the specified hardness. Material has been added to the entire stem to compensate for wear and pitting.

Compensating quality for the sake of saving may be justified in some things—but never in aircraft parts. Engine operation quickly reveals

weak components and the result may be both serious and costly.

The key to genuine engine economy is long-term component reliability. The best way to ensure this dependability is to always specify Pratt & Whitney Aircraft original equipment parts. They are quickly available direct from Pratt & Whitney Aircraft or from its authorized distributors throughout the United States and Canada.



Key test-area of many extra parts Pratt & Whitney Aircraft parts meet price.



Kelly Racor Spy I engine on BAC 111 is housed in pod (left). Developed by Kelly, which is double-engineered for easy maintenance access. Pod will access literally the same when type 25 propellers are installed on later models. Engine can be removed for overhaul in 1 to 15 min. BAC 111's night refueling point (right) just ahead of right wing root provides fuel entry at rate of 360 gpm.



Twin-wheel landing gear (left) was designed by Vickers Armstrong and retract sideways into center fairings. Design includes front, one to four full air emergency. Nose wheel retracts forward into nose section. Tail section (right) doors handle on Vickers VC10 experience and is presently a scaled version of the VC10 design. Elevators are normally controlled by spring tabs and one-piece rubber is hydraulically controlled by twin operating pistons installed at the base of the tail section.

**Pratt & Whitney Aircraft**

East Hartford, Connecticut

**United Aircraft of Canada Limited**

Longville, P.Q., Canada

# Airline Traffic—May 1963

	British Airlines (Miles)	Operating Passengers (Millions)	Revenue Passenger Miles (Millions)	Revenue Passenger Load (%)	Total Revenue Passenger Miles (Millions)	Average Gross Load (%)	Scheduled Miles (Millions)	Performance Factor (%)
<b>DOMESTIC TRAFFIC</b>								
American	10,194	713.2	340,084	36.2	79,950	4.47	10,193	88.9
Eastern	9,476	714.4	310,874	33.1	71,642	4.26	9,474	96.0
Continental	2,184	138.3	75,743	42.7	15,326	4.42	2,173	98.0
Delta	8,252	291.4	344,143	40.5	67,264	5.40	8,260	99.0
Northwest	9,459	316.0	319,000	33.7	65,004	4.40	9,459	97.0
National	2,221	179.7	129,413	60.9	16,311	3.24	2,243	89.0
Trans World	11,282	150.6	45,731	30.9	4,746	3.79	1,252	93.1
Midwest	3,017	202.9	107,173	40.2	14,812	3.72	3,016	97.0
Trans World	8,240	414.3	419,524	49.3	49,790	5.99	8,240	99.7
United	16,446	1,009.3	675,323	66.4	16,547	3.12	16,427	98.4
Western	2,217	200.7	107,439	48.26	11,259	5.10	2,217	99.0
<b>Domestic Traffic Total</b>	<b>83,918</b>	<b>4,416.6</b>	<b>2,991,326</b>	<b>59.4</b>	<b>342,422</b>	<b>3.22</b>	<b>84,106</b>	<b>99.5</b>
<b>INTERNATIONAL</b>								
American	134	9.1	2,148	47.4	1,203	5.44	144	100.0
Eastern	368	7.9	10,841	39.8	1,576	5.14	381	95.3
Continental	134	47.4	3,476	45.3	379	3.66	133	96.3
Delta	122	2.4	4,176	41.6	442	4.42	113	100.0
Northwest	1,835	49.6	69,750	44.4	4,169	6.15	1,933	94.9
Western	100	7.9	2,642	32.9	203	2.62	93	99.2
Trans World	931	30.6	46,107	41.2	6,196	6.76	954	96.4
Midwest	133	11.2	10,710	35.1	3,489	7.79	236	97.9
United	7,747	322.7	463,422	44.4	87,161	5.31	7,991	97.1
South Pacific	31	0.5	544	43.4	56	3.31	31	100.0
Trans World	272	12.9	29,149	36.2	2,104	9.23	194	100.0
Trans World	7,380	44.5	119,115	44.5	10,569	6.12	7,380	99.0
Midwest	553	19.5	49,820	44.3	3,313	9.44	249	100.0
Western	192	7.9	10,416	47.6	1,179	6.23	189	100.0
<b>International Total</b>	<b>16,183</b>	<b>597.2</b>	<b>1,081,497</b>	<b>52.5</b>	<b>136,402</b>	<b>6.32</b>	<b>16,414</b>	<b>99.8</b>
<b>LOCAL SERVICE</b>								
Airgraph	791	92.7	18,499	42.6	2,552	2.83	847	93.4
Eastern	438	45.3	15,459	46.4	1,619	3.18	519	91.9
Continental	431	59.3	8,211	37.6	754	1.73	430	91.4
Delta	919	40.2	10,437	38.6	1,160	1.33	917	99.5
Northwest	627	2.4	6,240	40.2	69	1.1	627	100.0
Midwest	1,208	91.7	29,478	47.1	2,146	2.08	1,249	93.4
Trans World	1,208	91.7	16,815	36.6	1,341	1.43	1,294	99.9
United	497	47.9	12,812	47.9	1,332	1.82	497	100.0
Western	494	42.4	7,440	36.0	944	2.13	490	99.9
Trans World	1,018	79.4	14,530	44.5	1,475	1.79	1,027	99.1
United	172	47.3	7,448	32.9	1.18	1.18	172	99.4
Trans World	490	36.0	9,830	39.5	88	1.16	494	99.2
West Coast	416	24.2	1,824	39.8	827	2.21	402	99.2
<b>Local Service Total</b>	<b>10,000</b>	<b>798.0</b>	<b>456,941</b>	<b>51.5</b>	<b>10,000</b>	<b>3.46</b>	<b>10,000</b>	<b>99.1</b>
<b>ALASKA &amp; HAWAIIAN</b>								
Alaska Airlines	238	9.1	4,201	22.7	1,618	4.12	156	99.7
Alaska Airlines	132	10.9	4,812	59.1	87	0.75	132	99.0
Alaska	175	27.8	4,228	10.3	248	2.00	169	97.0
Continental	48	4.8	1,454	30.6	64	1.36	44	97.9
Northwest	326	47.1	6,167	59.9	676	3.44	357	99.4
Western	46	1.3	93	29.7	11	0.23	29	96.4
Trans World	121	2.8	942	36.0	156	4.0	121	99.9
Trans World	237	14.8	14,548	51.1	1,104	5.59	232	99.9
Western	116	2.0	1,452	26.9	244	2.48	116	99.8
Western	116	2.0	1,452	26.9	244	2.48	116	99.8
Western	338	4.3	1,210	34.4	331	1.20	338	99.3
<b>Alaska &amp; Hawaiian Total</b>	<b>2,043</b>	<b>115.9</b>	<b>59,494</b>	<b>59.3</b>	<b>4,211</b>	<b>3.76</b>	<b>1,199</b>	<b>94.9</b>
<b>MISCELLANEOUS</b>								
Chicago	50	6.8	126	40.3	13	0.42	50	97.3
Los Angeles	70	16.2	887	45.2	64	0.92	71	97.3
New York	46	36.9	414	47.3	31	1.12	44	95.3
<b>Miscellaneous Total</b>	<b>166</b>	<b>59.9</b>	<b>1,999</b>	<b>47.1</b>	<b>107</b>	<b>0.87</b>	<b>165</b>	<b>95.5</b>
<b>CARGO &amp; PASSENGERS</b>								
American	54	4.3	327	70.4	0.84	0.84	58	97.8
Eastern	1,204	4.9	26,855	94.6	91,099	15.19	1,204	99.9
Continental	8	0.129	4.1	4.129	0.129	0.129	8	99.9
Delta	279	2.2	20,441	93.8	9,216	17.18	279	99.4
Midwest	619	0.5	1,370	37.6	6,200	14.84	619	99.6
<b>Cargo &amp; Other Total</b>	<b>2,026</b>	<b>36.5</b>	<b>69,331</b>	<b>57.1</b>	<b>63,888</b>	<b>10.91</b>	<b>2,026</b>	<b>99.9</b>
<b>Industry Total</b>	<b>104,285</b>	<b>5,409.9</b>	<b>4,454,062</b>	<b>59.9</b>	<b>549,740</b>	<b>3.59</b>	<b>102,742</b>	<b>97.6</b>

Reported by Ray & Ray

## BEA Chairman Urges Parliament To Reject BOAC Merger Idea

London—Airline management fight to keep the two British state-owned carriers apart came into the open here last week when Lord Douglas of Kinnaird, chairman of British European Airways, wrote 19 members of Parliament urging them not to support a merger with British Overseas Airways Corp.

Douglas' letter laid weight to speculation about the so-called Concorde Report: BOAC's financial situation will recommend a merger or, at least, a joint management board (AW July 8, p. 40).

In a memorandum accompanying the letter, Douglas said that, in the event of a merger, "the model would refer to the merger of BEA and BOAC." BEA is expected to show a mixed profit when its accounts are made public about next year, on the other hand BOAC probably will report another large loss.

### Points Examined

Points made to the MPs by Douglas include:

- Merged corporation would be very large, with about 35,000 employees. BEA now employs 16,000 and BOAC 27,000.

- Merged airline with two separate headquarters, short and long haul, would be difficult to control by one board and one management who could not devote enough time and attention to the particular problems of each.

- Traffic control by a merged BEA-BOAC from the U. S. to the Continent would not ensure satisfactory if they operated through, around, Douglas noted there are direct services to the U. S. and the Continent "and passengers don't like to be interrupted stop at London, unless they stop over at London, in which case a through service is of no advantage."

- Loss of interface revenue would result, particularly in dollars, because BEA is a North Atlantic carrier. The BEA chairman told the MPs that the major U. S. airline has raised a device to all its sales points that they are to give BEA points on revenue sales.

Douglas also mentioned there would be no savings in operating costs and administrative savings would be small.

Douglas claimed that in event of a merger, BEA's operations would, in effect, become just the European subsidiary of BOAC. Service, he said, might be possible from combining services, but that would be outweighed by a loss of revenue. Regarding costs, Douglas said that with no merger costs, one can act as a "lender" to

the other on labor and wage policies.

Another argument against merger, Douglas said, is that profits earned on BEA routes are never likely to be sufficient to offset the losses from BOAC operations if the airline's present rate of loss continues. A merged corporation then would be likely to have a deficit as long as BOAC had a loss, he continued.

Douglas pointed out that BEA's success has been due in large part to "its ability in its direction, and to a degree to be deflected from its present aim of operating as a strictly commercial concern." The continued

### Commercial Basis

"If BEA is to conduct its affairs on a proper commercial basis, it must be left free to do so. They are not intended to do so as a requirement the BEA to do, at not to do, something because of its effect on the merger as allowed to keep it, the minister is to run the business, probably, he has to do."

Meanwhile, BEA plans this week will receive union strike bulletins as a dispute with management over pension plans in Bristol and Bristol operations. The union includes a strategy group of management.

The Caribbe Report, or at least points selected by Minister of Aviation, James A. Smith, will be presented to Parliament this fall in a White Paper on air transport.

## Flag Carriers Favor Lower Atlantic Fares

Washington—First position reports of international flag carriers on a transatlantic fare structure filed with the Civil Aeronautics Board last week show a decided trend toward lower fares.

Reports also reveal strong differences of opinion on the first level and the type and quantity of passenger class which should be adopted.

No carrier appeared willing to cut fares to the level proposed recently by Pan American Airways with its third tier (AW July 8, p. 42).

One carrier noted simplification of the tariff structure while others proposed broadening of passenger fare plans.

Federal reports are currently circulating as to the fare and some, out of a basis of continuing negotiating which will be discussed by the formal meeting of the International Air Transport Association Conference beginning Sept. 7 at Salzburg, Austria.

"We'll ship it Air France—they're the world's largest airline"

This fact is repeating Air France is the world's largest airline. Air France carries cargo on the longest system of scheduled routes miles—251,000—of any airline in the world. Air France serves more cities in more than any other airline in the world. If you're a forwarder, you can book bulk freight shipments to Paris, Europe's largest break point. This forward your cargo on the same airline to nearly any capital city in the world. These all-glass H.E. Flights depart from here each week. Fly daily get people. (Air France also carries New Orleans, London, Los Angeles, Anchorage and Montreal.) For special cargo special aircraft diversions are quickly arranged. Where in the world do you ship to? Air France, world's largest airline, serves the area. Discuss this with your Freight Forwarder at Cargo Agent. Or call an Air France Cargo Service Office.

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## For the frozen frontiers: a family of steels to which zero means nothing

Strange things happen in the world of ultracold. Some metals get stronger but sometimes so brittle they shatter like glass. Others become superconductors. The load-carrying capacity of some fluctuates wildly. Material selection, in this strange Pandora's Box world, must depend on carefully accumulated perform-



This 56-in. long storage tank is fabricated of A516 steel plate, regular for service requiring notch toughness down to -100°.

### ASTM A201 and A212: for many years the only low-temperature steels available

These two carbon steel grades are widely used for a variety of storage tanks requiring notch toughness down to -100°, such as refrigerated vessels for the storage of liquid propane or ammonia.

ASME allowable design stresses (% tensile) are 15,800 psi for ASTM Grade B and 17,500 psi for ASTM Grade B.

Both grades are available in flange or flange quality. When specified to meet the rigorous requirements of ASTM A900 to -500°, the plates may be furnished as the minimum or non-minimum and stress-relieved condition to meet the minimum requirements for the specific application.



USS "T-1" Steel's excellent notch toughness, high strength, and weldability permit high working stresses at low temperature service.

### USS "T-1" Steel: can cut pressure vessel weight up to 50%

USS "T-1" Steel combines great strength (100,000 psi min. yield strength), weldability and low temperature toughness (20 ft-lb min. Charpy impact at -200°). It is particularly suited for highly stressed pressure vessels operating at temperatures down to -500° and vessels for handling LP gases, and welded lightweight structures.

Present ASME stress for "T-1" Steel is 26,700 psi for plates up to 2" thick. In new Code vessels, "T-1" Steel has been used at allowable stress levels as high as 30,000 psi.

In a series of dynamic burst tests, USS "T-1" Steel vessels without internal hydraulic pressure up to 2600 psi at about -400° before bursting, equivalent to circumferential stress of 16,000 psi. Another series of "T-1" vessels, refrigerated to about -400° and pressurized to 1875 psi were tested to destruction by impact from a 13-lb mass dropped successively from 55, 75, and 101 in. An impact energy of nearly 2,500,000 ft-lb-in. was required to rupture the vessel.



This 75-in. nickel steel shell affords low storage capacities at temperatures ranging from -150° to -200°.

### USS 2½% Nickel Steel: down to -750°

2½% nickel steel has been used widely for tanks, vessels and piping handling liquid propane and other liquefied gases at temperatures down to -750°. It has been used particularly by the chemical industry for process and equipment vessels. Specified uses include equipment such as static skid-mounted test chambers operating at temperatures as low as -400° to simulate 70,000 ft. depths.

2½% nickel steel is preferred by ASTM A201, Grades A and B. Grade B is most widely used because of the excellent deep-fracture toughness compared to 18,200 psi for Grade A.

These steels are also covered by SA-302 of the ASME Boiler and Pressure Vessel Code.

ance data. We have a wealth of such data at United States Steel, plus comparative design studies, that will make your material problems easier. Ask for a USS cryogenics specialist by calling our nearest sales office, or writing United States Steel, Room 6834, 525 William Penn Place, Pittsburgh, Pennsylvania 15230.



Low density, tested 9% nickel steel vessel was refrigerated to -150° (propane) to simulate 100,000 ft. depths. Shell stress, minimum of 50,000.

### USS 9% Nickel Steel: excellent strength and notch toughness down to -320°

Developed, tested and proven for cryogenic service, 9% nickel steel offers a sure combination of high yield strength, toughness, and weldability. It is particularly suited for large-pressure cryogenic processing equipment, and for the transportation and storage of liquid carbon dioxide, nitrogen, and argon. Because it doesn't require special relief after fabrication in most steel thicknesses, it is a natural for large field-erected tanks and vessels.

The ASME allowable working stress of 20,500 psi (Code Case 1908) is more than double that of 10,000 psi permitted for aluminum alloy 6061-O. These thicknesses can be reduced to less than half those of aluminum with suitable reduction in cost per square foot.

Where strength is vital, 9% nickel steel is a natural alternative for aluminum. Its use of fabrication results in substantial savings; data accumulated to date suggest savings of at least 10% of final erected cost compared to aluminum vessels.



2½% nickel steel vessel tested simulated, showing other things the high toughness of nickel steel up to 14 miles and more.



Type 304 stainless steel heat exchanger shows strength, stability and shock resistance at deep-cryogenic cooling of -410°.

### USS 3½% Nickel Steel: used for land-based facilities and ocean-going tankers

Low carbon 3½% nickel steel has been used for land-based facilities for the containment of liquid propane, carbon dioxide, acetylene, ethane, ethylene and other difficult gases at temperatures down to -175°. Its excellent low-temperature toughness makes it suitable for use in refrigerated tanks to transport liquid ethylene. Its formability, also excellent, has resulted in its use for tanks, vessels, piping, valves, flanges, heads, and many other components.

3½% nickel steel is covered by ASTM A201 Grades D and E. Allowable design stresses are 26,000 psi and 15,500 psi, respectively. These steels are covered under SA-303, ASME Boiler and Pressure Vessel Code.

### USS Type 304 Stainless Steel: the #1 cryogenic metal down to absolute zero

The austenitic chromium nickel stainless steels, 304 and 304L, are by far the most popular metals for cryogenic service down as low as -400°. They are used widely in liquid oxygen production and storage, and the storage of liquid hydrogen and liquid helium. Wherever high purity is required, such as handling liquid metals, stainless steel is a must because its surface remains chemically clean and won't react.

Type 304 stainless steel is easy to weld and fabricate, doesn't require stress relief after fabrication, and possesses high strength with excellent strain ability and shock resistance at very low temperatures. Its allowable design stress is 26,150 psi.

304L and "T-1" are registered trademarks.



**United States Steel**



This mark tells you a product is made of metals, dependent steel.

## AIRLINE OBSERVER

Continuing stretch of U.S. travelers from foreign flag carriers to U.S. airlines on North Atlantic routes (AW June 5, p. 36) is creating a serious overcapacity problem for a number of foreign carriers. Both Pan American and TWA are reporting substantial gains for the number of passengers carried on the route during the first six months of this year. Pan Am said its share of the market has increased by 42% in this period and TWA's revenue passenger miles jumped 36% over the same period last year. But the total traffic carried by the 15 airlines serving North Atlantic routes rose only 1%. The explanation can be found in the big jump in capacity. Available seats in the first half of the year for all airlines climbed 37% and the number of flights increased 12%. The overall load factor for the 15 airlines in the North Atlantic dropped 6% points to a low 45%.

Jockeying of U.S. government agencies for control of the development of a aerospace transport continues to delay the start of a definitive program. Both National Aeronautics and Space Administration and the Federal Aviation Agency are examining cautiously for the moment. Last month, the Aeronautical Systems Div. of the Air Force Research Command was busy establishing a temporary transport project office. There were eight candidates for director, seven of them general officers. Last week, however, the effort was sharply halted, suggesting that the Air Force project may have collided with the program under way at NASA.

Allard R. Short, head of the Civil Aeronautics Board Rates Div., is slated to attend the International Air Transport Assn. Traffic Conference in Sofia, Bulgaria, as official U.S. observer of proceedings (AW July 29, p. 36).

British Overseas Airways Corp., taking a cue from the other nationally owned airlines, British European Airways, has applied for permission to sell standby fares on the London-Manchester and London-Glasgow routes in an attempt to fill empty seats. BEA claims an extra 50 passengers a day are attracted by the standby arrangements, which offer lower fares. BOAC would not lose by one-third if approval is granted.

Tasman Empire Airways, Ltd. (TEAL), the New Zealand national airline, will pay for its three Douglas DC-6s in payments (AW Aug. 12, p. 38) through an overseas loan of \$25 million. F. A. Reeves, TEAL general manager, said loan and interest charges will be spread over company revenues.

Rapid development of the Turbofan Astoria 10 turbo-prop engine has made it possible for Short Bros. & Harland to increase gross weight of Turbo-Skyvan transport to 12,500 lbs. with a 4,000 lb. payload. The engine will be offered by the production Turbo-Skyvan but the prototype, now being modified, will fly with two Astoria 2 engines for flight test purposes. Astoria 10 develops 640 city-hp, against 538-hp for the Astoria 2.

Continental Airlines is struggling of public opinion against doubt about the future of its airline for three Air France Concordes, expensive transports. Company officials said "these Concorde are in line in the next six years for Boeing 707s and we're living them." He said published statements implying that the order for the Mach 12 aircraft was a publicist's "junk" "not worth mentioning." Rejection of the announcement of intent, he said, is the first the \$50 million purchase has been cleared with Continental's board.

Progress in air transportation is sometimes a relative thing. A 1993 fare-basis shows that a shuttle service not operated every hour on the hour between Washington and New York (Newark) at a one-way fare of \$14.75. Federal Air Lines current Air Shuttle rate is \$15. The 1993 service was offered by the old New York, Philadelphia and Washington Airway Corp.

Daniel government will be in the conflict zone for passenger behavior as it implements a decision to try to attract traffic to Cleveland. Airlines plan to fly to Cleveland in Cleveland. Since then, Southwest Airlines System's report at Southeastern Flyer. Darden have shown an interest in the St. Louis 3-61.

## SHORTLINES

Allegiance Airlines has reported a net income of \$81,000 on gross revenues of \$12 million for the first half of 1963. This compares with a net income of \$346,344 on gross revenues of \$11.1 million during the first six months of 1962.

Civil Aeronautics Board has ordered Western Airlines to restore service on its scheduled route between Feb. 4 and June 30 operating schedule. The Board found that Western had discontinued service between Fargo, Fargo, Agency, Sioux, and Ames, Western Sioux, for a "substantial time."

Federal Aviation Agency has selected 39 technical papers dealing with all-weather landing systems for presentation at its second International Research and Development Symposium at Atlantic City, Sept. 16 through 18. Sixteen foreign governments have indicated they will be represented at the symposium.

Flying Tiger Line has reported a net loss of \$835,942 after a provision for a federal income tax credit of \$977,000 for the first six months of 1963. Gross revenues for the period were \$19.2 million, compared to \$25 million in the first half of 1962, when net income reported was \$1 million.

Lake Central Airlines last week sent an aircraft restoration team to France where it will study the Nord 262, twin turbo-prop transport (AW June 10, p. 36). Nord has proposed special route studies concerning the operation of the 19-passenger service on Lake Central's routes.

National Airlines has shown a 30% increase in enroute transit traffic as the Miami market this summer is compared with the same period last year.

Trans World Airlines will place into service this week one of the six Canadair 560 aircraft which it purchased from General Dynamics Corp. earlier this month (AW Aug. 12, p. 41). The planes have been on lease to Northeast Airlines but General Dynamics earlier had demanded that the fleet be returned because Northwest was \$48 million behind on lease payments (AW June 24, p. 40).

United Air Lines flew 1.2 million passengers 860.7 million revenue passenger miles in July. The carrier said these figures are industry records.



Multiple radiographs show detail in both ends and disk sections.

It says "STOP" to a landing aircraft



Magnified radiograph of wheel brake in metal.

This part of an aircraft wheel-brake, cast in magnesium alloy by The Willman Bronze and Aluminum Co., is radiographed to show it is sound and ready for its job.

With the safety of an airplane in stake, the integrity of the casting must be proved. Also the internal passages for the pneumatic and hydraulic systems must be shown free of all foreign material.

So the Willman Bronze and Aluminum Co. of Bay City, Mich., inspects each casting by radiography.

Two films, Kodak Industrial X-ray Film, Type AA, and Type M are exposed at the same time. In this way, both thick and thin sections are correctly radiographed simultaneously.

Makers of castings, as well as fabricators find radiography a big factor in product integrity, in satisfying customers, in attracting new business. To find out how radiography can help you, contact an X-ray dealer or write us to have a Kodak Technical X-ray Sales Representative call.

Two outstanding Kodak Industrial X-ray Films

Type AA—Fast film gives high contrast. The most widely used film in industrial radiography.

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# Basic Gemini ECS Keyed to 14-Day Flight

By Harold D. Welton

Los Angeles—Environmental control system (ECS) for the Gemini two-man spacecraft will combine state-of-the-art advances in proven Mercury concepts with new components made necessary by the more stringent mission requirements of the second generation manned space vehicle.

With few exceptions, wherever Mercury ECS concepts were adaptable to Gemini, the changes made were evolutionary rather than revolutionary. The great majority of alterations were brought about by the change in the mission, which required an environmental system to operate safely for the equivalent of four man-weeks (two men for two weeks) as compared with 28 man-hours in Mercury.

Elaboration of Mercury system design concepts is particularly evident in the life support segments—the rail and cabin loop—both of which are modified and improvements are indicated by the fact that only two wires in the Gemini ECS are identical to hardware used in Mercury.

Central tank for the Gemini system is basically the same as for Mer-

cury—to maintain a safe and comfortable pressure atmosphere for the human crew within the space vacuum.

The AirResearch Manufacturing Co., a division of The Garrett Corp., which developed and built the Mercury ECS system, is also responsible for the Gemini system, working as it did in the current project, under subcontract from McDonnell Aircraft Corp., prime con-

tractor for both spacecraft. Overall supervision is provided by the Gemini project office of National Aeronautics and Space Administration's Manned Spacecraft Center at Houston.

Detailed requirements of the Gemini ECS are to provide oxygen for breathing and pressurization, to remove carbon dioxide, moisture and odor from the cabin atmosphere, to provide for water supply management both for crew and cooling, and to furnish ventilation and temperature control for crew, cabin, equipment, and fuel cells.

## Basic System

Basic ECS system that AirResearch has designed for Gemini is for the extended 14-day, zero-gravity mission being planned. Essentially the same system, with acceptance of amount of expendable supplies, will be used on shorter missions, with the greatest difference being on a 4-day mission.

Total weight of Gemini ECS system, completely serviced with expendable, will be 518.55 lb. for two days and 464.29 lb. for two weeks.

The Gemini system, now undergoing early manned development test chamber studies, will, like Mercury, be a single-loop oxygen atmosphere, maintained at a nominal 5.1 psi in which first oxygen supply will be purified by expendable chemical.

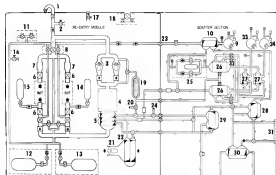
The overriding design goal continues to be the greatest degree of assurance that an single equipment failure will cause no effect on crewability other than to disrupt the crew.

Due to the greater number of systems, the amount of redundant equipment to permit this safety is greater than in Mercury.

## Reduced Automation

Increased confidence in man's capabilities in space has permitted some relaxation in extent of instrumented controls, with a resulting increase in degree of reliability due to less complexity, according to Richard G. Nelson, AirResearch's program manager for Gemini ECS. At the same time, the system is designed to require the least possible amount of astronaut attention.

Temperature control on Gemini is expected to be considerably less time-consuming than at Mercury, where maintaining the small amount of water for evaporative cooling was difficult. Water management techniques and the greater complexity level of systems are expected to be better in Gemini than in Mercury.



**SCHEMATIC OF GEMINI** environmental control system shows model valve (10), recirculation valve (11), compressor (1), air flow restrictor and odor absorber (15), suit heat exchanger and water separator (12), evaporator disconnect (16), air flow (17), recirculation valve and shield valve (18), ECS pressure oxygen container (19), primary oxygen heat exchanger (18), dual cabin pressure regulator (21), secondary oxygen supply separator No. 1 (22) and No. 2 (23), oxygen separator (24), carbon dioxide separator (25), carbon dioxide separator (26), carbon dioxide separator (27), carbon dioxide separator (28), carbon dioxide separator (29), carbon dioxide separator (30), carbon dioxide separator (31), carbon dioxide separator (32), carbon dioxide separator (33), carbon dioxide separator (34), carbon dioxide separator (35), carbon dioxide separator (36), carbon dioxide separator (37), carbon dioxide separator (38), carbon dioxide separator (39), carbon dioxide separator (40), carbon dioxide 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cury (17), dual cabin pressure relief valve (18), water tank (19), drinking water relief valve (20), cabin fan (21), cabin heat exchanger (22), quick disconnect (23), cabin water pump (24), pump package (25), fuel cell (26), heat exchanger (27), evaporator disconnect (28), heat exchanger (29), heat exchanger (30), ground cooling heat exchanger (31), quick disconnect (32), dual O<sub>2</sub> pressure regulator (33), secondary oxygen supply separator No. 1 (34) and No. 2 (35), cabin pressure regulator (36), carbon dioxide separator (37), carbon dioxide separator (38), carbon dioxide separator (39), carbon dioxide separator (40), carbon dioxide separator (41), carbon dioxide separator (42), carbon dioxide separator (43), carbon dioxide separator (44), carbon dioxide separator (45), carbon dioxide separator (46), carbon dioxide separator (47), carbon dioxide separator (48), carbon dioxide separator (49), carbon dioxide separator (50), carbon dioxide separator (51), carbon dioxide separator (52), carbon dioxide separator (53), carbon dioxide separator (54), carbon dioxide separator (55), carbon dioxide separator (56), carbon dioxide separator (57), carbon dioxide separator (58), carbon dioxide separator (59), carbon dioxide separator (60), carbon dioxide separator (61), carbon dioxide separator (62), carbon dioxide separator (63), carbon dioxide separator (64), carbon dioxide separator (65), carbon dioxide separator (66), carbon dioxide separator (67), carbon dioxide separator (68), carbon dioxide separator (69), carbon dioxide separator (70), carbon dioxide separator (71), carbon dioxide separator (72), carbon dioxide separator (73), carbon dioxide separator (74), carbon dioxide separator (75), carbon dioxide separator (76), carbon dioxide separator (77), carbon dioxide separator (78), carbon dioxide separator (79), carbon dioxide separator (80), carbon dioxide separator (81), carbon dioxide separator (82), carbon dioxide separator (83), carbon dioxide separator (84), carbon dioxide separator (85), carbon dioxide separator (86), carbon dioxide separator (87), carbon dioxide separator (88), carbon dioxide separator (89), carbon dioxide separator (90), carbon dioxide separator (91), carbon dioxide separator (92), carbon dioxide separator (93), carbon dioxide separator (94), carbon dioxide separator (95), carbon dioxide separator (96), carbon dioxide separator (97), carbon dioxide separator (98), carbon dioxide separator (99), carbon dioxide separator (100).

Major components in Gemini system are as follows:

- **Primary oxygen supply** will be stored at atmospheric pressure in a cryogenic liquid tank, rather than in a high-pressure gaseous storage vessel as in Mercury. Significant state-of-the-art is required to permit this concept to be used in Gemini.

- **Primary cooling system** of Gemini is a liquid in a heat transport loop through which coolant fluid (MCS-130) flows in series through ECS heat exchangers, evaporator and condenser and back to a space radiator for cooling. The Mercury ECS and water boiler for cooling suit and cabin gases directly. The large quantity of water required for two-man mission ruled out a water boiler. A total of seven heat exchangers are used for cooling and heating in the Gemini ECS, compared with two in Mercury. Two other heat exchangers are employed in the Gemini gas reactant supply system for fuel cells.

- **An integrated heat exchanger** water separator is employed instead of the separate heat exchanger and mechanically activated pump-type (MCS) separator in Mercury. The Gemini water separator

removes water vapor released directly through a venting manifold positioned through the plates of the heat exchanger. Static void, operating with capillary action and no moving parts in common, simplicity and reduced power use and weight. While the entire method was judged adequate, the work is expected to permit a more consistently compact and efficient design.

- **Water management system** has been simplified and redesign achieved in use of fuel cells as power source, instead of batteries as in Mercury. Gemini's oxygen and hydrogen are combined in the fuel cells to produce electrical power. Water is a by-product of the reaction.

- **An additional life support system** had to be developed by AirResearch for the midcourse abort-type operation used for missions short in Gemini. This provides pressurization and oxygen for breathing at altitude up to 74,800 ft on cabin launch in Mercury. Mercury depended upon an escape rocket system to separate the entire spacecraft from the launch vehicle in an abort in launch.

- **Gemini vehicle-side program** of checking module construction and placement of components for use of gas-tightness is carried out in ECS. Air-

Research designed 49 different components to McDonnell assembly in Mercury ECS. Gemini system has 114 components, but 54 of these are being commonized into 11 modules. This offers 10 to be delivered separately. AirResearch estimates that entire Gemini suit loop system module can be refined in 40 man-hours. It took 24 hr to mount carbon dioxide separator system alone in the Mercury's "pole-on" installation. Work is now under way to develop a design for the chemical leak container to which tanks are connected for attaching other components.

Major segments of ECS will be divided between the adapter and re-entry modules of the spacecraft. In the adapter, which will be pressurized prior to launch, will be primary oxygen supply and major heat transport loop components. Upon arrival of the adapter, the ECS will shift to a different mode of operation. Primary suit and cabin loop system modules will be in the pressurized cabin.

As in Mercury, the Gemini suit and cabin provide cooling, pressurization, purification, and water removal for gas in the suit loop. The cabin loop also provides cooling and pressurization, but



**ARTIST'S RENDERING SHOWS** Gemini spacecraft as orbit adapter attached with re-entry module. Environmental control system is shown, upper right, a spherical tank containing primary oxygen supply. Below it to the right is another spherical tank containing water boiler heat exchanger which cools to space. Two large circular tanks at bottom are oxygen and hydrogen supply for fuel cells. See cabin pilot's suit and one long intercom line (cabin loop) below. Large of the cylindrical pressure bottles below pilot to right is one of two secondary oxygen supply bottles. Directly below pilot are two smaller oxygen bottles for each emergency oxygen system. On right half of cabin are various components of the cabin loop.



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does not have separate gas purification and water removal components.

Other functional groupings are the fresh oxygen supply (pressure and wet outlet), the water management loop, the exhaust loop and the emergency oxygen system. The reactant supply system (RSS) for fuel after the oxygen and hydrogen separation, cryogenic storage and demand-type regulation is also being supplied by AikResearch under separate contract.

Phases of the particular system are considered essentially a matter of convenience by NASA and AikResearch officials. In general, the wet system is primary for ventilation and purification, and the other within its primary pressure vented with the wet loop's back-up.

Basic requirements of the crew suit loop in orbit are to provide a nominal wet temperature of 70°F, ensuring a total metabolic load of 100 Btu/hr/m<sup>2</sup>. Nominal design points for gas temperature is 55°F at the suit inlet and 50°F at the suit outlet. Relative humidity is designed at 30% at suit inlet. Ventilation rate provided in orbit use of two alternate duct-thru centrifugal and flow compressors is 15 to 40 ft per minute with a pressure rise across the compressor equal to 10 in. of water.

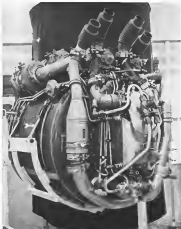
### Contaminated Oxygen

Upon exit from atmosphere suit the contaminated oxygen is exhausted through a debris trap and then through a charcoal canister where carbon gas is removed by a layer of activated charcoal and carbon dioxide is removed by lithium hydroxide. Extensive use of the canisters will be made for both the short and long missions, but since construction will differ, with springs being used to take up slack.

A charge of 4 lb of charcoal and 11 lb of lithium hydroxide will be carried for two days, and 0.65 lb and 8.1 lb respectively are specified on a two-week mission. The charcoal canister is 27 in. in length and 21-16 in. in dia.

Purified oxygen is then cooled and dehumidified in the integral heat exchanger and wet-loop water separator. Water from cooled gases condenses in the heat exchanger and is absorbed and exhausted to the water storage tank. In the process water is removed which is used for water storage tank and water separator. From the heat exchanger the dehumidified oxygen is returned to the crew.

Gas pressure in the suit loop during the approach orbit and departure is regulated to maintain 1 psi, under the nominal oxygen pressure of 5.3 psi, as demand for the suit from the helmet. As suit loop pressure is reduced by purification and dehumidification makeup oxygen is supplied as demanded from two suit pressure demand signals (operating in parallel).



**SUIT LOOP SYSTEM** module for Gemini environmental control system is built around charcoal canister containing activated charcoal and lithium hydroxide for air purification. Module also includes, in addition to canister, air flow out door tubes at top. Two water drains lead to wet inlet and outlet two in. from suit outlets. Down from opening on extreme left that is one of debris traps in orbit tube. Box-like component in center of module facing to right of canister is heat exchanger and water separator. At upper left, on top of canister, are two compressors. This is example of production module now being made by AikResearch.

Pressure in the suit loop will follow a drop in cabin pressure until the suit reaches 3.0 psi, where the suit inlet valves will close. This would seal off the suit loop to maintain pressure, in either a physical or emergency cabin depressurization.

The suit loop relief valve also prevents excessive suit pressure, limiting the suit pressure to from 2 to 3 in. of water above cabin pressure. In orbit operation, the suit loop pressure will rise above that of the cabin as oxygen is added to cabin through suit loop to compensate for cabin leakage.

If some reflection should prevent pressure in the suit loop to drop to 5.3 psi, a high-rate oxygen flow would begin to immediately flow either primary or a secondary supply. In this mode the oxygen flow would be open-cycle—

not accumulated through the loop—and would be limited at a high-flow rate of 1 ft/min/area, to provide both ventilation and cooling. Nominal rate of consumption is approximately 1/12 lb of oxygen for each man per hour.

Inlet and outlet ducts from Gemini atmosphere scrub are located in lower chest area. Mexican inlet was on the front and the outlet was inside of the helmet.

Due to operation scrub decontaminates, the ducts leading to and from the suits are first connected to regenerative scrub, which in turn is connected to base suit loop.

Crews 825 loop on Gemini space suit is unable to tolerate concepts such changes in composition to compensate for the release of carbon to 80 in. It takes 50 sec. to in the Mercury cap-



**Problem: duplicate this environment...**

**and then maintain it out here**

Before America's first manned space station goes into orbit, a whole new generation of problems will have to be met and solved.

To keep the crew in good health, for instance, we'll have to maintain their Earthlike environment for months or years. We'll have to devise a supply system to get food, air, and all the other necessities up to them regularly. We'll have to keep all their equipment in operating condition. We'll have to be able to work on the outside as well as the inside of the station. We'll have to develop vehicles and techniques for shuttling personnel to and from the station, as well as for in-space rescue.

Lockheed-California foresaw the scope of these problems five years ago, and brought together a team of scientists and engineers to specialize in man-in-space. The SpaceCraft Organization has developed a high degree of capability in all aspects of space station design. They have conducted extensive studies of techniques and vehicle designs for supply, maintenance, rescue and logistics in space. Today they stand ready to undertake the many vital tasks upcoming in this challenging new age of man-in-space.

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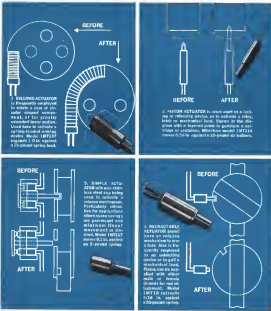
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## Four basic explosive actuators . . . and how to use them effectively.

Explosive devices are being used more and more widely in a variety of aerospace and ordnance applications . . . or wherever you need miniaturization, unmatched reliability and just one-time performance. The key to effective application lies in simplicity . . . you can design with a minimum of mechanical parts or electronic circuits. The four actuators illustrated are representative of many variations of explosive devices developed from Atlas electro-chemi-mechanical research. We would like to work directly with you to develop the specific device that will match your requirements. Please call us, or send for literature.

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**PROTOTYPE OF GEMINI ICS** combustion heat exchanger and water separator for test loop, with sliding manifold positioned between exchanger plates, is shown. Water from cooled oxidant gas condenses on the fin and is absorbed by porous wicking material which permits water passage but prevents or gauges absorbed water is transferred to storage tank. Fluidization can separate debris from this model, although work arrangement is pending.

rel and reduced heat loads. Primary color loop components are a plate-fin heat exchanger through which gas is pushed by an oxidant flow fan. The loop also contains a relief valve for both positive and negative pressure relief, a pressure regulator to maintain color pressure, and control valves to either dump color pressure or regenerate. In the latter operation, oxygen is fed directly into the color.

Operating design points call for an oxidant color temperature of 560°K, and color oxidation rate of 35 cc./hr./sq. in. at 5.1 psi. The Mercury system was set at 32 cc./hr./sq. in. Color heat load from instruments, engine and other sources, almost all of which must be handled by the fan and heat exchanger, is calculated at 450 Btu/hr.

Design color leakage rate of 12.50 cc./min. at 5.1 psi. compares with 500 cc./min. rate in later Mercury spacecraft. Making torque to maintain color pressure at potential 5.1 psi level is offset for by the color pressure regulator. The gas first passes through the test loop, in order to obtain maximum utilization of oxygen. It is then dumped into the color, through the test pressure relief valve, as there positive test pressure from ring more than slightly above color pressure.

Subsequent primary oxygen supply for the test-day mission will be 13.3 lb. of usable oxygen in a 12.2 lb. 14-day supply. For the 14 day mission, a 30.97 in.-dia. circular tank will hold 801 lb. The primary tank has an inner shell of Inconel-718 and outer shell of titanium.

The primary supply will feed into a system reservoir with the secondary supply. The latter will be cycled in two cylindrical tanks located in the pressurized section of the nearby module. Each secondary tank is a welded-invariant of module construction with individual control components mounted other to the tank as to backfill about 50 ft.

Secondary tanks will each hold 6.5 lb. of usable oxygen at 5,000 psi on both short and long missions, in the secondary supply functions are the same in both. In case of malfunction of primary tanks, each tank is capable of providing both oxygen with sufficient oxygen at desired rate for one 90 sec. orbit, plus 30 min. recovery period. During recovery, oxygen is supplied at the high flow rate (1 1/2 lb./min.) for fuel burning, cooling and for purging in of carbon dioxide.

Oxygen flow is controlled by a higher pressure setting (110 psi) on the primary oxygen regulator than on the secondary oxygen regulator (55 psi). When both are connected to the test system and functioning properly, oxygen flows exclusively from the primary source. A pressure drop in primary system below 55 psi automatically releases oxygen from the secondary tanks.

### Oxygen Tank Filled

In preparation for space flight, the supercritical pressure oxygen tank is filled with liquid oxygen at atmospheric pressure and capped. To hold pressure to the critical point of 736 psi., heat is applied to the tank from thermal leakage through the tank insulation or by a battery electric heater in order to release all the liquid.

Above the critical pressure, the fluid is a homogeneous mixture, described for simplicity as a dense oxygen gas. During flight, pressure will be kept at 518 psi. by action of the heater upon activation by a pressure sensing switch. While pressure maintained above critical pressure, only the gaseous state of fluid can be handled by the system components. The cold gas leaving the primary tank is warmed to approximately 540°K in a heat exchanger. When excessive pressure is generated by a relief valve, heating maintains pressure to 1,000 psi.

Downstream from the heat exchanger, a pressure regulator reduces the oxygen pressure to 110 psi. for delivery into the test loop. This demand regulator for each unit further reduces this to the nominal 5.1 psi.

Heat transport fluid which serves the main heat exchangers on Gemini, as well as the equipment cold plates and fuel cells, will be a Mersin-1000 silicon ester fluid (MCS-100). Primary material of heat from the coolant loop in orbit will be provided by a space radiator which

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an ARINC 821 type DME system in a large 3/4 ATR size) and the DMA-29A for aircraft where ARINC standardization is not required, packaged in a short 1/4 ATR case. Both feature solid state switching. The DMA-29AL is also available for bridge-type frequency control. Both cover all VOR/DME channels with provision for future channel splitting. Both precisely indicate distance from 0 to 192 miles.

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**Bendix Radio Division**



INVI



**TECHNIQUES AT AIRESEARCH** test one of secondary oxygen supply tanks (left) for Gemini RCS at a high pressure oxygen test stand. In Gemini spacecraft a tank such as this will hold 6.5 lb. of usable oxygen at 5,000 psi. Two such tanks will comprise the secondary oxygen supply which will be used to back up primary operational pressure supply. Secondary supply will also be used as a safety after primary supply is exhausted. Technicians are (right) to check dimensions of specialized storage tank for primary oxygen supply to Gemini RCS. Smaller of two tanks shown here, will hold 15.5 lb. of usable oxygen.

a long bolt by McDowell as a stress test part of the adapter module. Tubing of the radiator will be of T-shaped extruded magnesium alloy, which will serve both as fluid conductor and structural stringer. Heat will sink through the bolt and T legs to a 100 sq. ft. magnesium alloy heat sink surface at the aft end and will be dumped from there by radiators. There will be two completely independent backup cooling loops: 1. the space radiator, two coolant loops will run through aluminum stringers.

Location of heat-generating systems in the adapter and in legs surrounding the pressurized cabin complicated the problems of heat dissipation. In Gemini, with one system inside the cabin, convection cooling by circulating oxygen cooled the equipment.

### Coolant Circulated

In Gemini, equipment outside cabin will be mounted on hollow aluminum cold plates through which the coolant will be circulated.

Under normal operation, the flow of coolant will out from the space radiator at approximately 400 ft. per second by one pump or as a coolant loop. Primary path of the coolant is the usual orbital mode would be flow radiator through the launch water boiler heat exchanger.

For additional cooling, if necessary, a pump will flow in the cabin and heat loop heat exchangers, then to cold plates, fuel cells, pumps, primary oxygen heat exchangers, RCS heat exchangers, the sensitive heat exchangers, and then back into the space radiator.

Two positive-displacement gear pumps are provided for fluid circulation in each loop. Selection of loops and number of pumps is controlled manually.

Maximum cooling load in the heat transport loop is limited, preferably, by one pump operating in each loop simultaneously. However, two pumps can also operate on a single loop for rapid cooling.

If coolant fluid should escape from the space radiator below the maximum design temperature of 410° F, the fluid will automatically be circulated through the two regenerative heat exchangers for the necessary warming.

Since the space radiator is ineffective both on the ground and during launch, two other heat exchange systems, also in the adapter, are employed to cool the heat transport fluid prior to reaching orbital orbit.

Before launch, a ground heat exchanger in the spacecraft cools the RCS coolant with water. MCS-140 fluid which is circulated through ground loop side of the heat exchanger from a launch pad vent.

During launch, a water boiler launch cooling heat exchanger will go into operation as the decrease in ambient barometric pressure gradually opens a valve. Effective boiling is expected to start at 300,000 ft. altitude, such thermal lag expected to prevent significant heating between liftoff and shut point. Several pounds of water stored in the boiler's tank is expected to be consumed during the launch phase. This water boiler will

be used during peak heat loads in orbit to back up heat transport loop, and at also serves in emergencies back up in case of failure of both coolant loops.

Dealing in many respects from Mercury's water boiler, it will go into operation during orbit when a temperature sensing device opens a valve and releases pressure, thus causing the water in the exchanger to boil. A cooling manifold is used to draw water across the plates in the exchanger.

### Makeup Water

Makeup water for the water boiler and for the 160 lb. oxygen tank for crew drinking and washing will be provided by fuel cell sections at a rate of 0.5 lb./hr. and by condensation of exhaled gas at the rate of 3 lb./man/hr. Water from fuel cells is discharged into the 160 lb. core storage tank. Water from hot loop water separator, however, can be manually directed either to the water boiler or to the crew tank.

If the crew storage tank should be full, fuel cell water production is automatically directed to waste boiler. If that tank is full, water is diverted as a liquid waste into cooling is needed, in which case it would go overhead in stress. If the boiler relief valve should freeze in the process of dumping liquid, thereby creating excessive pressure in boiler, an electric heater on the valve is manually switched on. Waste is also direct to the boiler tank.

The flow of water either to or from the crew storage tank is a matter of a three-way valve, and with two pres-







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Aerospace plastic experience at GAC—Goodyear Aerospace Corporation—covers everything from vision for jet pilots' helmets to enduses for space vehicles—from high-temperature-resistant cockpit canopies to 140-foot-diameter ground-level enduses—from glass filament-wound motor cases for the Polaris A-3 to radomes for Gemini reentry vehicles.

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**Some aerospace systems with Goodyear Aerospace Corporation plastics:** McDonnell; F4C • Long-Term Vought; F8D and Navair F5A (cockpit) • Grumman; A-1A (cockpit radome) • Boeing; T-47 and T-47 windows • RCA; RIMKWS 140-foot plastic radome. Plants in Akron, Ohio, and Litchfield Park, Arizona.

GAC participated in the development of and is now producing the plastic filament-wound first stage motor case for the Polaris missile. GAC has been working on filament-wound since 1946, built the first plastic rocket motor case qualified for U.S. production.

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## FROM SOLAR COMPASS TO AVIONICS



Solar Compass (American LOR)—Used to indicate the direction of true north by a single observation of the sun's position. A similar device was used in 1955 by John Belushi's Byrd on his military flight over the South Pole, an area where no known reliable magnetic compass was available. (Dennis Mowery)

### AVIONICS BY AC MEANS—LOW SYSTEM COST, ON-SCHEDULE DELIVERY, ACCURACY AND RELIABILITY

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ation through action of the relief portion of deaerated regulation.

In orbit, the cabin pressure bleeds down to 5.1 gms., due to leakage, where it is maintained by the cabin pressure regulator.

The astronaut suit loop temperature is controlled by a combination of automatic and manual systems. Temperature of the coolant fluid passing through the suit loop heat exchanger is controlled automatically. Rate of fluid flow is controlled manually. Each astronaut will also be able to regulate the temperature of his suit individually by means of a handle controlling the inflow of cool oxygen. Temperature and flow of coolant through the cabin heat exchanger has manual and automatic adjustment similar to the suit heat exchanger.

During the orbital mode of operation, the ECS system is compatible with extra vehicular activity (EVA). The re-compression capability, which is necessary for an astronaut to move outside the spacecraft in space, has been provided in order to allow any time that might begin in a 100% oxygen atmosphere used to purge the cabin or suit loops of a high carbon dioxide level or toxic gases. Decontamination is accomplished by currently opening the valves on flow valve. ECS purges oxygen supply is designed by Allcochem to prevent three decompressions during the basic flight mission.

NASA Gemini project officials at the Marshall Spaceflight Center say that EVA is "delicately in the plans" (AW

Aug. 12, p. 210). However, they have not yet established an exact mission EVA will last be attempted. Another, portable, life support system will be developed for EVA, as Gemini project officials have short ruled out use of an umbilical cord attached to the spacecraft ECS even for backup.

Dennis R. Collins, NASA spacecraft manager for the Gemini project, said that chances of snagging and of a pressure drop in the suit loop that could be caused by a long umbilical led to the decision. Standby would be in the personal system carried inside the suit. At present, NASA thinking is that only a tether line, and possibly a communication line, would be attached to an astronaut venting outside the Gemini cabin.

The only part of Gemini life support loop that would be utilized in EVA, therefore, is the suit, which is being furnished by David Clark Co. Its EVA capabilities are now being evaluated, and changes probably will have to be made in the suit to ready it for movement outside the cabin.

The recovery of containers carried in conventional control system from the Mercury project is referred in plans for early extraneous two photo operations in Gemini.

In early flights, it is anticipated that one astronaut will stay completely helmeted up, while the other crew member helmet and gloves. After further consideration in the system is gained, both crewmen may be presented to take all their helmets and gloves at the same



### Mariner Panel Fabrication Started

Fabrication of main panel structures for Mariner Mars fly vehicle (AW May 6, p. 96) has begun at Ross Aircraft Co. Fabricators will have four sub panels with combined area of 78 sq. ft. attached to basic structure. Launch vehicle will be Atlas-Agena D.

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—Observer present



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time. The extent of supervisor operation will depend to a large degree upon astronaut's decisions.

During operations, the cabin recirculation valve would be opened to permit carbon to be drawn through an air loop for purification and waste removal.

Recirculation mode of the ECS serves as a means of fundamental checks from orbital operations due to action of the adapter actions containing the primary oxygen and heat transport loop components.

In preparation for operations, the coolant system is turned up to maximum for a cold-soak to reduce equipment and system temperatures as much as possible.

### Lines Sealed

After getting on the adapter, all gas and fluid lines are sealed by quick-disconnect and the secondary supply of oxygen is automatically begun. The crew will then manually switch to an open-cycle, high-rate flow of oxygen for re-entry.

In this mode, the compressors are turned off and the main loop is taken off valve is closed. The system is designed so that the entire supply of air safety oxygen will be consumed on re-entry.

AirResearch expects that the temperature during re-entry will reach no higher than 75-80°F in the suit and 100°F in the cabin.

Ambient air is drawn into the suit loop beginning at about 20,000 ft, where the inflow valve, leading to a recirculated tube outside cabin, and outflow valve are opened manually.

The automatics turn on the compressors to recirculate the suit loop. But life power will not compress after re-entry.

### Pressure Increase

Pressure in the cabin and suit is gradually increased during re-entry by action of the inflow relief valve which limits negative cabin-to-suit pressure differential to 15-20 in. of water. At approximately 20,000 ft, when outside pressure is equal to the nominal 5 psi inside capsule, the valve permits outside air to enter the pressure vessel.

Manual controls for ECS entry will be centrally located between systems so that either crew can make the necessary adjustments.

Instrumentation, located on the outer panel, will display temperature and pressure of the cabin and suit loop, carbon dioxide partial pressure, coolant pump flow rate, primary oxygen circuit pressure, quantity of primary oxygen supply, and secondary oxygen supply.

Warning lights will indicate when water storage tank is full and excessive

pressure in the water boiler. With the exception of the water tank status, all this information also will be telemetered to the ground.

With major new elements in the ECS system and flight testing scheduled to be limited to one ballistic flight with a trained simulator, extensive ground tests are scheduled to prove out the design prior to the first manned flight.

### Mercury Lessons

Development and reliability testing are both expected to reflect lessons learned during the Mercury program. Joseph L. Gelfman, AirResearch's Gemini test manager, said that testing of Gemini components will include comprehensive environmental tests of vibration, temperature and altitude, and that reliability will be verified by extensive over-stress testing.

Neither of these techniques were used in the Mercury environmental control system test program.

Manual verification of the suit and cabin gas loops began in mid-July at AirResearch's Los Angeles facility, and preliminary tests are also being conducted by McDonnell at St. Louis, which has received suit and cabin loop components of the first two systems. AirResearch now is installing a test transport loop in its test section for the next stage of tests.

General overall assessment of ECS systems made by Collins, NASA's Gemini spacecraft manager, reflects overall Gemini program slipping. "Phase now call for test of the complete system, including the space suit being fabricated by McDonnell, by 1964."

## Re-entry Study Facility Underway at Utah Site

A \$1 million construction program to support the on-orbit portion of USAF's Altair/Altair missile re-entry, phase-out study program is underway at Gortz Ranch, Utah, with completion scheduled for next month.

About 500 military and civilian personnel from White Sands Missile Range, USAF and Atlantic Research Corp., contractor for the re-entry program, will be based at the new facility during the two-year operation. The launch complex will include four firing pads, the McDonnell and a 500-ft. reconnaissance tower. The site will also include two FPS-16 tracking radars and a storage area for housing rocket components. Prime contractor for the facility is Olson Construction Co., Salt Lake City, Utah.

AirResearch Construction Engineering Co., El Paso, Tex., was prime contractor for the tower.

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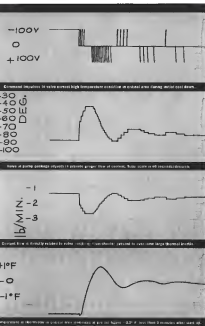
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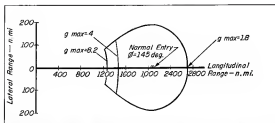


Clark fit up to experience. Since 1947, United Control has designed and manufactured a variety of reliable aerospace and industrial temperature control systems, proving them in the field, the laboratory, and with actual computer studies even before prototypes are produced. Today, reliable temperature control like United Control's, each fresh requirement can be satisfied quickly and efficiently, satisfactory service is greatly simplified, and unsurpassed reliability is included only by outstanding economy.



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ing. The common mode will be held to the level of a c. voltage (proportional to the desired level). Engine on-off signals will be in the form of an on-off signal.

The guidance and navigation (GN) system will coordinate critical equipment for the modified Apollo spacecraft system. The design has sought industry preparation for this equipment for a long effort in the study.

The guidance and navigation system will be self-contained, with no reliance on any earth or space station data link, except for a possible link to the space station just before departure from it. A responder will be available in the space station for real-time guidance.

## Guidance, Navigation

Guidance and navigation system will contain control, optical, radio and other sensors, a guidance computer, pilot displays and visual control facilities, and backup GN capability. Pilot perhaps has in GN operations will be limited to those tasks which can be performed without leaving the couch.

The system provides attitude control commands to the stabilization and control system, and direct on-off and thrusting commands to the main propulsion engine. The stabilization and control system includes rate gyro, zero keep electronics, jet-aided logic and pilot control stick. It sends signals to the actuator control system and the main engine control system in accordance with attitude error commands from the GN system or in accordance with pilot lateral and longitudinal commands.

Pitch, roll and yaw error signals will be provided by the GN system during all mission phases, except during storage and during inventory, when only a signal will be provided.

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will be able to provide the signal for entering in orbit.

The system will be capable of accepting the spacecraft into a 100-mi orbit (a 20-mi orbit or a 20-mi orbit in a parking orbit for 12 hr), and the guidance and navigation system will be capable of providing a Hohmann transfer to the 200-mi orbit.

**Rendezvous Guidance**  
The GN system will provide guidance from the entering point of ascension to the arrival point of specified position and velocity dependent on required by the docking operation.

For the acquisition mode, estimated range capability will be 100-mi mi with responder as the space station and 15-mi mi, if there is no responder support. Range rate will be 800 ft/s, and angular rate of line-of-sight will be 0.1 rad/s per sec. These values will be modified if necessary.

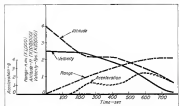


CHART SHOWS constant-velocity trajectory parameters for a 2-deg, steady angle from a 11-deg orbital inclination with the legions spacecraft.



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position combines the Hohmann space transfer with the rendezvous. The rendezvous will only on the gravitational and thrustable arm space.

Reaction-type jet (large module) will be used for orientation of the space craft.

For the last several thousand feet, visual control will be exercised by the astronaut, using optical aids.

In the docking mode, orbital relative velocities will be 0 to 2 fpm for engine approach.

Radial alignment of spacecraft will have to be within 12 m for the location of the X-axis (orbital axis of symmetry) with respect to the docking mechanism axis.

Angular alignment of the spacecraft during this maneuver will have to be within 10 deg.

Spacecraft footprint, depending on pitch, will be between approximately 1,150 and 1,350 sq ft longitudinal range and between 75 and 150 sq ft on lateral range after side of the longitudinal range line.

## Nuclear Power Studied For Space Stations

Los Angeles—Detailed studies of nuclear electrical power generating systems for manned orbiting space stations are being performed for National Aeronautics and Space Administration's Lewis Research Center by two industry contractors.

•General Electric's Nuclear Div. is studying reactor heat sources using both thermoelectric and dynamic (Rankine or Stirling cycles) power conversion, under a \$61,220 contract.

•Martin Co.'s Nuclear Div. is studying isotopic heat sources for static power conversion systems, under a \$40,091 contract.

One of the studies (AW July 8, p. 27) is to provide sufficient data to allow design to incorporate nuclear power on space stations only in the design phase of the program.

Space systems envisioned for application of the power system include the following configurations (AW Apr. 1, p. 70):

•Rotating radial Y-type. Radient launch date for this configuration is considered to be the 1967-69 period. The station will accommodate 12 to 30 men, will have a station life of 1 to 5 years, and will require 12 to 35 kw of power. The station will be 138 ft in diameter and 20 ft deep, and orbital altitude will be 116 to 160 mi.

•Cylindrical type. Radient launch date for this configuration is 1967. It will accommodate 3 to 6 men, station life will be 1 to 5 years, and power required will be 2 to 5 kw. Diameter will be 32

## PROBLEMATICAL RECREATIONS 184



A one-acre field in the shape of a right triangle has a post at the midpoint of each side. A sheep is tethered to each of the side posts and a goat to the post on the hypotenuse. The ropes are just long enough to let each animal reach the two adjacent vertices. What is the total area the two sheep have to themselves, i.e., the area the goat cannot reach? —continued

We hope you'll all be WERCON-bound for Proectors in Electronics at San Francisco's Cow Palace, August 20-23. Marking our 12th LEXUS booth this year will be the numbers 3205-3211 and 3212-3217. You'll find us within the limits of the south annex on the main floor. Try and make it, huh? We'd like to see all our readers there. Non-readers welcome, too.

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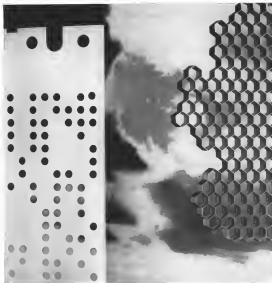
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## Program for a mission, pattern for a launcher

Punched cards and aluminum honeycomb played an important part in the development of an advanced ECM simulator, and production of a lightweight launcher for ASROC. While the design problems were different, they were solved by a similar capability—engineering skill and ingenuity offered by Universal Match Corporation's Government Products Group.

A simple punched-card system provides a flexible method for programming the T-4 Electronics Countermeasures Simulator, developed by Raytheon Electronics, Inc., a UMC subsidiary. T-4 can duplicate virtually any SP condition which a B-52 ECM officer might encounter over enemy territory.

Engineers at UMC's Undynamics Division combined light

weight and high strength needed for ASROC's unique launcher through use of honeycombed aluminum. The unit not only needs eight modules above deck, but also serves as baffle. This innovative design technique points the way toward more reliable launchers of increased mobility.

UMC's Government Products Group offers the capability for solving many diverse problems, and the ability to design and produce advanced systems important to our defense posture.

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403 Paul Ave., St. Louis, Missouri 63102

tt., length 22 ft. Orbital altitude will be 190 to 200 mi.

The studies are not limited to systems available in the 1967-69 period, but include more advanced concepts.

The studies are divided into two phases. Phase 1 is a feasibility analysis which defines space station power and environmental requirements, assesses the nuclear launch associated with operation at low altitudes and sideways required, and considers effect of radiation hazards on normal operations (including assembly repair and escape). Competitive position of nuclear electric power with respect to other power systems (fuel cells, solar cells, and solar dynamic and solar thermionic systems) also will be analyzed. Phase 2 will be completed early in November.

After review of Phase 1 results by NASA, Phase 2 will be initiated. The first task, under Phase 2, will be to provide ground performance data including a comparison of static and dynamic cross section ratios, a comparison of isotopic and reactor heat sources and radio isotope in weight, cost, and powerplant configurations.

The nuclear launch will be analyzed with respect to a range of orbital altitudes. Space station configurations and dimensions will be analyzed with relation to shield weight.

The second task, under Phase 2, will be a conceptual design of a nuclear electric power generating system which will have shielding for normal operations, docking, repair, refueling and escape.

Other factors to be studied include radiator design, structural integration and control, start up, shut down, and start methods. Life of the powerplant will be considered with respect to power level and number of start-stop cycles. Longevity of life support, vehicle stabilization, and nuclear power reactors also will be studied.

Third task, under Phase 2, will be to define the optimum nuclear electric powerplant for manned space station, given the potential for stations of the SNAP power system now under development, and modifications and development required to adapt the SNAP system for space station applications.

### Life Support Study

Study of the chemical and nutritional aspects of dehydrated food and drink will be conducted over the next two years using rats as subjects as part of USAP. School of Aerospace Medicine's work on development of a life support system for humans.

The study, to be headed by Robert Francis Lamberth of Chicago, will determine whether the diet will be able to support growth and what would make these products nutritionally complete.



This little remote control package took two hands to get the right answer.

This intercomometer will show the stability at two intervals within a half-second time of 250 to 500.

It will perform reliably under temperatures from minus 55°C to plus 80°C, with a voltage range from 10 to 50 volts. Its size is 1 1/2" x 3 1/2" x 1 1/2".

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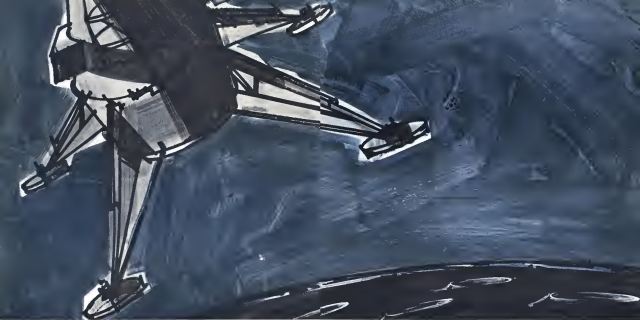
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## USAF Tests Water Retrieval System

Cock Electric Co. has developed water retrieval system for USAF which is applicable to recovery of man, animal and expendable payload from space. USAF is testing system in Lake Michigan. Heart of recovery device is a small motorized boat (right) powered by electric motor. Boat is dropped from aircraft and lowered into water by parachute. Aircraft crew manually guides boat to target (see drawing above) by sequence of up-down-boat. Boat can also home in on target if latter contains beacons. When boat reaches proper depth, it fires rocket line (see target with hook-and-dropper gun). Boat then surges close to target, gathering and cutting target, jettisoning line. Fire boat man to then fire net over target, and payload must be hoisted on boat. Aircraft lowers rescue device, switches used and returns target. Second must be used for recovery of boat or man only.



## New Radar Telescope to Map Ionosphere

By Philip J. Klein

**Arecibo, Puerto Rico**—An unusual radar telescope, 40,000 times more powerful than the Millstone Hill radar which first made contact with the planet Venus, will become operational within several weeks here at the Arecibo Ionosphere Observatory.

The novel facility, believed to be the world's largest and most powerful scanning radar, was built under the sponsorship of the Advanced Research Projects Agency at a cost of about \$5.5 million. It will enable scientists for the first time to map a detailed profile of the entire layers of the ionosphere, the shell of ionized particles surrounding the earth which plays an important role in terrestrial radio communications, in ICBM detection and tracking and which possibly affects our weather.

### Natural Bowl

The 1,000-ft. dish antenna built into a natural excavation bowl is powered by 2.5 megawatt peak-power transmitter operating at 430 mc. The antenna is expected to have a gain of 60 db and generate a beam whose width is less than 1/4th deg. Photographs do not adequately convey the gigantic size of the new observation or the construction job involved in its fabrication.

Previous radar telescopes, both here and in the Soviet Union, have only been able to make contact with Venus, Mars and Moon when the planet were in close proximity to the earth. They

also had to rely heavily upon data processing to extract the weak radar echo from the background noise. The Arecibo facility should be able to track out to these planets at any time that they are within the field of view of the radar and obtain a directly observable signal, according to Dr. Gordon Pettigall, associate director of the observatory.

Radar contact with even more distant planets, such as Jupiter and Saturn, also may be possible when they are in proximity to the earth.

While the Arecibo facility will greatly extend the reach of radar in astronomy, its primary objective is to make a detailed study of the ionosphere. Fear to the advent of the space age, scientists were seriously handicapped in efforts to probe this multi-layered ionospheric shell which ranges from a few miles to about 100 mi. in altitude.

The availability of satellites and rocket probes has provided greatly increased knowledge of the ionosphere, but because such probes and methods can explore only a limited section of the ionosphere at any time, and because the composition of the layers changes with time of day, season and solar conditions, it is difficult to obtain a complete profile and sort out cause from effect. This is the void which the new observatory seeks to fill.

The Arecibo Ionosphere Observatory is the brain child of Professor William E. Gordon of Cornell University, who was appointed director of the facility. He suggested that the nearest back-

stopping from free electrons in the ionosphere at ultrahigh frequencies (UHF) was sufficient to provide a detectable signal. Measurement of the magnitude, spectrum, bandwidth and variations of these parameters could be used to determine the distribution of free ions and electrons in the ionosphere and to study the effect of solar flares and so-called "gravity waves."

The weakness back-stopper is, in fact, that the conventional cone beam radar, the ionosphere is considered to be transparent above frequencies of about 30 mc.

### Important Role

Gordon proposed using a high-power transmitter and an extremely large (high gain) antenna. Because the properties of the ionosphere place an inherent limit on ICBM detection and decoy discrimination, the Advanced Research Projects Agency in 1955 agreed to fund the concept as part of its Project Defender program for exploring new ICBM defense techniques. Cornell University and the Army Corps of Engineers were named as prime contractors with the Air Force Cambridge Research Laboratories assigned to provide technical management. Construction got under way in 1960.

Recognizing the technical difficulties and extreme cost of building a conventional radar antenna of such huge dimensions, Gordon proposed that a stationary dish on a natural bowl with an overhead feed which would permit

the beam to be steered over an angle of 6 deg. over side of vertical. By locating the feeds near the equator, rotation of the dish would provide 360-deg. azimuth rotation in the azimuth plane, with a view of the entire sky.

At Cambridge Research Laboratories, imposed upon this idea is suggesting a technique that would permit the beam to be steered through an angle of 24 deg. from the zenith. This important improvement was made possible by a research study which had been conducted almost a decade earlier by three AFRL scientists, Dr. A. G. Stenzel, C. J. Betts and J. E. W. G. They had developed a relatively simple technique which permitted use of a spherical (rather than a paraboloid-shaped) reflector with a planar feed source employed in precise direction. (For a description of the technique see sketch p. 34.)

The Arecibo Ionosphere Observatory located roughly 12 mi. south of the Puerto Rican city along the northern coast whose name it bears. The site was selected after an extensive survey of areas located near the equator whose topography provided natural bowls. The observatory is situated at approximately 18 deg. north latitude and 66 deg. west longitude, enabling it to scan the entire plane. The mold exists here, with a temperature variation of less than 30 deg. during the year, a favorable to dimensional stability of the large antenna. The surrounding hills offer some protection against high winds and severe electromagnetic interference.

### Spherical Form

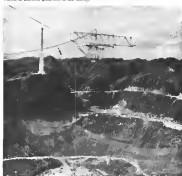
Despite use of a natural bowl, construction had to dig and blast out nearly 300,000 cu yd of material while about 100,000 cu yd of dirt were added to shape the bowl into a spherical form. Because the radar beam can be steered only 24 deg. one side of the zenith and about 40% of a hemisphere had to be constructed for the dish. Thus the radius of dish curvature is 375 ft. while the distance across its upper lip measures 1,300 ft. Total dish surface is about 18.5 acres.

The 96-ft. long planar area feed line is supported on the dish by means of a triangular-shaped platform, supported by three sets of four cables suspended from 300-ft. radius towers. These cables are spaced at 120-deg. intervals around the bowl. Each set of four cables consists of four 5 in. dia. cables. To provide rigidity in space, the triangular platform is anchored by means of 1 1/2 in. dia. tie-down cables. Two of the towers are 260 ft. high. The third is 351 ft.

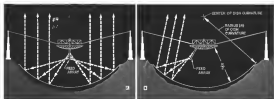
A 340 ft. long, concentric-disk structure, called the level arm, is supported from the triangular platform by means of a concrete track, with electric motors used to rotate the arm in azimuth. The



**SUSPENDED FEED** for Arecibo observatory, seen in construction close-up, shows 340-ft. long concentric-disk arm which rotates in azimuth from large ring and two center towers underneath which will mount long planar feed lines, not yet installed in this photo. Two orange towers near top are support towers in towered opposite ends of arm to keep structure balanced. Note top of antenna concrete supporting tower-one of three from which the platform is suspended at lower right of photo. Support is by means of three sets of four cables, each consisting of four cables of 5 in. dia. Also, right corner points to marker in limestone point one of the facility.



**NEW RADAR TELESCOPE**, believed to be the world's largest, most powerful scanning radar, 40,000 times more effective than Millstone Hill's radar, is expected to become operational near Arecibo, Puerto Rico, soon. Size of the facility can be gauged from group of workers in foreground. Left center shows on 740-ft. long overhead rail to verticalize the antenna. The 96-ft. long feed arm is suspended by cable from three towers of reinforced concrete, one of which can be seen in background.



**ARECIBO RADAR'S ABILITY** to scan 26 deg. off the vertical with feed dish results from use of technique developed by Air Force Cambridge Research Laboratories more than a decade ago. Arecibo uses spherical dish and 96-ft. long planar area feed line instead of conventional paraboloid-dish reflector and point source. By using lateral dimensions of square waveguide feed line to control square amplitude reflected at each point along its length, and the length of radiating lines to control phase of energy, the spherical dish shows no in-phase, equal-amplitude feed source as shown in (A) above. To steer beam to scan other vertical angle, concentric beam arm, about a curvature which keeps top of feed arm always at a distance of one-half dish's radius of curvature from the dish, is shown in (B).



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(Continued on next page)



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**GIANT DIAL**, covering 350 acres, is made from panels of steel mesh which are supported by grids of cables that cross over in north-south and east-west directions. The dense cables and ballast rods are adjusted to give desired spherical curvature to dial.

underside of the dome is located 435 ft above the bottom of the dish, corresponding to half the dish's radius.

Along the curved underside of the dome are two tracks running lengthwise from which are suspended two small "caveat houses," one on either side of the center. The physical load here is suspended from one of the two caveat houses, while the other passively carries ballast rods later will be equipped with a feed line designed to operate at different frequencies.

To aim the satellite beam with respect to the vertical, the caveat house carries the 90-ft. feed line moves out from the outer (caveat) position, while the other caveat house is close to the opposite direction to balance the structure. Thus the two caveat houses move in unison, either toward or away from the center of the present-shaped area. To aim the beam in azimuth, the cable-shaped rods are soldered with respect to its supporting triangular plate faces.

The entire structure, weighing about 100 tons, is designed to be so rigid that the 100-ton feed line will not shift position by more than an inch in the presence of a 10-ft. wind, according to Philip Blacksmith, A/CRL project officer.

Work already is under way to build a 200-ton structure to permit such movements to be made at 40 sec. intervals with time at 435 sec., to eliminate the effects of frequency. Pittsburgh is hopeful that later the Arecibo facility can be equipped to operate at frequencies up to 1,420 mc., corresponding to the hydrogen line radiation frequency, and that the in-balance of the dish and its feed will permit such operation.

The dish itself is fabricated from

panels of steel mesh ("chicken wire") which are secured to steel cables that cross over the bowl in north-south and east-west directions. Ten bridge strand cables, each 1½ in. dia., set at 100-ft. intervals, run in a north-south direction to provide a stabilizing frame for the structure. To provide the desired curvature and rigidity, these main cables are secured at 16-ft. intervals either to a vertical tie-down cable or to a set of three guy cables.

Consequently, in an east-west direction are 315 cables measuring 1 in. dia. which are clamped to the north-south cables at cross intersections and loaded with steel ballast rods to form a spherical structure.

The sheets of 1½ x 4 in. galvanized steel mesh in widths of 5 ft and lengths of 15 ft, are placed atop the cable grid in areas of a special design supported by cable. (See photo above.)

The individual sheets are clamped together for good electrical contact and attached by wire to the east-west cables at 15 points.

Because the steel mesh is being laid while close up work still is underway on the feed platform overhead, the reflector reflects dropped tools, trash, organic particles and the like. To

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## Arecibo Unclassified

The new Avionic Isotachonic Oscillator, with its huge potential solar microwave is now completely unclassified and the results of its exploitation of the ionosphere and solar system are expected to be made fully public. Originally, classification was applied to the possible use of the facility to detect nuclear explosion at space or the ionosphere.



## Beech-built "missing link" ends make-believe training

*KD2B-1, now being produced under U. S. Navy contract, is another example of Beech's systems management capability*

The Beech KD2B-1—shown above—is America's first ramjet target system to match the performance of the latest enemy jets. It ends the need for target towing, faltering, or simulation of any sort. By matching actual supersonic aircraft speeds, altitudes and target characteristics, it makes possible low-cost realistic training. It can evaluate proficiency of every advanced weapon system, including radar-directed and test-seeking missiles.

But weapons evaluation is only one of the many jobs the Beech KD2B-1 is capable of doing. It has capabilities for use as an inexpensive operational

missile. Its payload capacity and low-maintenance design fit it admirably for a wide range of tactical missions.

The KD2B-1 is easily adaptable to air-launching, surface-launching, or ship-launching with existing equipment. It is capable of Mach 2 speeds at 39,000 feet and Mach 3 speeds at 200,000 feet.

Designing, developing and building missile systems is one of the many elements that make up the comprehensive Beech capability. It's one reason Beech is prepared to undertake complete systems management responsibilities for a wide range of space-age projects.

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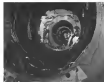
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## BIGGEST SPACE CHAMBERS BUILT... BY PDM

PDM has designed and built two space environment simulation chambers for NASA's Goddard Space Flight Center at Greenbelt, Md.—the largest high vacuum chambers built and tested to date. Each a 33' 6" x 58' high, has a fully removable head, a stainless steel shell and a g-4 polished interior surface. One is shown here.

These almost-identical twins were designed for ultimate  $1 \times 10^{-6}$  mm Hg operation. One is equipped for ultra-high vacuum and has been shakedown-tested below  $1.4 \times 10^{-6}$  mm Hg—a full decade better than specified. The other is planned for dynamic testing at lesser vacuums—but is suitable for future upgrading.

In the meantime, these "almost" twins provide flexibility, performance and full-scale checkout capability for the largest space vehicle systems.

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**SLOTTED WAVEGUIDE** running along underside of conical-shaped arm, with lines to keep set leads and shrapnel objects, shields radio energy to storage house and its feed line.

clear the debris without damaging the mesh, cleanup operation will use solar sails, according to Percy Wilden, business manager for the observatory.

The 2-megawatt transmitter, built by Radiovac of Scotland, is housed in the 5,000-sq-ft spectrum building of the observatory. Transmitter energy is spread by waveguide to the base of tower T-12 located due north of the center of the dish on the 12 o'clock pedestal, then along a 780-ft-long conduit out to the suspended platform, for a total distance of north one-third of a mile.

A large rotary joint, which permits 500 deg of azimuth rotation, houses the microwave energy to the conical-shaped feed horn. The latter contains a 100-ft-long slotted waveguide which permits energy to be transferred to the storage house and planetary feed line in this change elevation position.

The storage house is outfitted with two complete low noise "front-ends" to permit reception of both horizontally and vertically polarized signals simultaneously. Each includes a low noise Zenith electron beam type preamplifier amplifier low noise RF amplifier, crystal mixer and intermediate frequency preamplifier. But concerning the received 450 mc signal to 30 mc for transmission to the receiver in the spectrum building. Design objective is to achieve an overall noise figure of 2.90K, according to Blackwell. The system was designed and built by scientists at Goddard.

The solar transmitter, using Keweenaw Station tubes, can be operated either as a pulsed cathode with peak power of 2.5 megawatts or as a continuous wave mode with 150 kw average power output.

Transmitter is designed to generate a variety of pulse waveforms with repetition rates of 1-1,000 per second and pulse durations of 100 microseconds to 10 microseconds, according to Dr. Petrignelli. Both the transmitter and receiver have been installed and under

test have for more than a year, using a small feed horn as a test receiver during this period.

The operations building facility includes a Control Data Corp. 660A digital computer which will be used as a preliminary data processor for gross analysis of observation data. A digital control console, supplied by Magna Electronic Corp., will be used to transform celestial coordinates of planets to locate the required antenna aiming point.

The Amesbury Commonwealth Observatory will be manned by a staff of approximately 15 professional scientists and engineers plus an additional contingent of 25-35 persons for support and maintenance. Approximately one-third of the professional staff and half of the support group are natives of Puerto Rico. Additionally, students from the University of Puerto Rico at San Juan are expected to find summer employment here.

Puerto Rican officials have been extremely cooperative in accommodating the needs of the new facility, according to Blackwell. The Puerto Rican Government Authority, built a special electric substation and run feeder lines underground to minimize the possibility of cable interference. The present project is a significant step toward the use of rotating observatories in the vicinity of the observatory. While the job was not been a problem to date because the area is largely agricultural, it is a valuable possibility.

The \$8.3 million plan to build the new observatory, including a mile of access road, is several million more than the early estimate. Despite the unexpected increase and lack of experience in building comparable facilities, Blackwell says a hard-fought project office, running on fixed-price contracts rather than cost-plus-fee for contract for the 96-ft long planetary feed built by Technical Research Group (TRG).

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neighborhood of a detonation. A rate of 10<sup>10</sup> fission/gram/sec. is now routinely regarded as the threshold of perceptible (but not most) components).

• **PN junction field effect transistor in transient radiation environments**—gas tubes no better than the best high-pressure bipolar transistors was available (both appear to be degraded at levels of about 10<sup>10</sup> fission/gram/sec.).

• **Thin film resistors and capacitors** are less susceptible, by about one order of magnitude, to transient nuclear radiation than are comparable bulk, process-durable passive components of the type made available today by a number of

semiconductor manufacturers for breadboarding experiments.

These results could have a bearing on the selection or use of microsystems for systems which must survive in a transient nuclear environment. For other reasons—their potential reliability, portability of manufacturing techniques, light weight and low power consumption—microsystems are gaining favor for use in new weapon systems, and in unattended equipment for defense. But the process of hardening systems which must survive in the transient environment might preclude the use of certain types of microsystems or dictate design

in higher-level combinations, until quantities of microsystems economically available from two manufacturers were compared in various transient environments. The two events had roughly the same logic capability. Significant radiation effects occurred in one position at the 10<sup>10</sup> to 10<sup>11</sup> fission/gram/sec. level, while the same effects did not appear in the other. A significant clue, until the radiation level increased by an order of magnitude.

The difference, according to Robert W. Marshall, member of the industrial staff here, can partly be attributed to the use in the Sigatex device of a higher frequency transistor. Generally, higher frequency transistors are less susceptible to transient radiation. The reason for this is that high frequency transistors have narrower base regions and the magnitude of induced injected currents due to transient radiation are directly proportional to the area and width of the transistor's base.

#### Significant Hypothesis

Of more significance, however, is the hypothesis, explained by Marshall, that the need to isolate transistors from regions within the semiconductor substrate tends to create large area back-to-back PN junctions, the basis of the diodeless. Typically, the collector region of transistor are defined, as in N-type material is a P-type base. The collector regions of the two transistors are separated by a P-region which effectively becomes a measure made for a pair of large diodes formed with the two collector regions. Transient radiation tends to create leakage paths through the diodes to ground, effectively grounding the collector. This is a problem that the device which are deposited on modeling substrates do not have.

Of the two types of semiconductor microsystems compared, the Sigatex unit, as indicated in an accompanying diagram on p. 33 has only a single

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neer doesn't have to be present while it's testing. All the engineering skills are on the punched Mylar tape that feeds Datco instructions. So the test program will always give consistent results regardless of the experience, training, or background of the operator.

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**TEST CIRCUIT** used in determining the level of substrate diode connected to ground (transistors of heretofore mentioned transistor). Where diode is connected there is an appreciable increase in collector leakage current, comparable to what can be expected in a semiconductor microsystem.

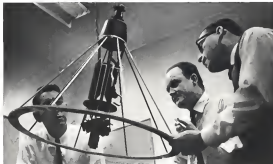






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The SNAP-8 nuclear turbo electric space power conversion system, under development for the National Aeronautics and Space Administration to provide 10,000 hours of continuous operation in space, is the kind of reliable, long duration power that will become increasingly important in the ambitious years ahead as manned orbiting laboratories are launched... deep space probes push off to such planets as Mars and Venus... permanent lunar bases are established.



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## Microcircuits Survive Van Allen Belt

Semiconductor manufacturers produce three different microcircuits now down extended radiation exposure to cosmic radiation to indicate they could operate for at least one hundred years below the outer Van Allen Belt if the type of radiation were the limiting factor on their lives, according to Motorola Honeywell's Automatic Div. in St. Paul, Minn.

Honeywell modified the firm tests on microcircuits which it conducted with the University of Florida Training Center at Gainesville, Fla. The company's interest was growth in the state with space exploration, quite different from the mobile computer-based environment explained at Hughes (see p. 96). It is directly concerned with the ability of digital computers using semiconductor microcircuits to survive the dose effects experienced by orbital vehicles traveling in the outer Van Allen Belt as exposed to radiation dose rates. Thus, its investigations centered on the persistent effects of integrated systems from straddling in high or 10<sup>11</sup> neutrons/cm<sup>2</sup>, rather than with high gamma dose which cause transient malfunctions in analog circuits.

Gamma ray effects were experimentally screened out.  
Honeywell currently is producing a computer consultant for the Air Force's NTR (Deep Sea) program, which uses Fairchild semiconductor-based NTR. Computer engineers tested five groups of microcircuit-based space-oriented Signetics SE 1001 gates later Fairchild's "G" gates in tandem, but Texas Instruments SN-514 gates in series, two discrete component NAND gates and five IN785 transistors to permit monitoring of transient beta deposition.

The circuits were tested in the University of Florida 1964, water-cooled orbit reactor which is capable of producing flux rates of 2 to 10<sup>11</sup> neutrons/cm<sup>2</sup>-sec. The circuits were exposed in steps to gradually increasing flux rates so that circuit responses could be monitored at different rates to be sure rate of radiation, rather than integrated doses, were producing any damaging effects.

The circuits were exposed to an integrated dose of 10<sup>11</sup> neutrons/cm<sup>2</sup>-sec, according to the dose, they would encounter in a continuous orbit within the Van Allen Belt at altitude 500 miles duration (total dose per year would be 2.2 x 10<sup>11</sup> neutrons/cm<sup>2</sup>-sec), about 3.6 x 10<sup>11</sup> neutrons/cm<sup>2</sup> for one hour of exposure to a solar flare near the earth.

At 2.2 x 10<sup>11</sup> neutrons/cm<sup>2</sup>, an integrated dose which would be experienced only after about 100 years continuous exposure at the Van Allen Belt, Honeywell says the output from the Texas Instruments microcircuit chips disappeared. At the end of the test, the Fairchild chips showed some deterioration in wave shape, reflected in increased asymmetry in the output waveform. Neither the Signetics chips, possibly because of simplified higher speed transistors use the excess integrating components showed any deterioration. Honeywell design engineer Terry Bollen, who was a co-participant in the tests, stresses that all of the realizations achieved at integrated dose levels will beyond the environmental of cumulative interest in the investigation.

their exposure do not introduce additional disturbances. The peak dose rate was 1.7 x 10<sup>11</sup> Roentgens/sec. With the solar ages (satellite dose rate) increased, the peak current pulse during radiation rose 94 microamperes. When the activity declined, following the shade of the radiation dose, the peak current rose to 167 microamperes. The shade in the circuit is thought to complete the current path for current injected into the collector region by pulse radiation, causing greater changes in the current response.

Semiconductor microcircuit radiation dose tested and found to have a flux of 10<sup>11</sup> Roentgens/cm<sup>2</sup>-sec, while flux rate systems, obtained from Madras, exposed to 10<sup>11</sup> Roentgens/sec showed only negligible effects.  
An integrated dose drop in a low resistance current operated without its influence when exposed to transient rates up to 10<sup>11</sup> Roentgens/sec. A good quality high speed transistor in a similar circuit probably would be destroyed at levels between 10 and 10<sup>11</sup> Roentgens/sec.

Twice effect transistors have been found by Westinghouse to be more resistant to permanent radiation damage than a specific bipolar transistor type, but they have been reported to be at least as sensitive to the best high frequency transistor available on the market.

Since field effect transistors are non-polar devices, unlike bipolar transistors, which are, actually, carrier devices, they might prove to be more resistant to permanent radiation damage. The reasoning behind this is that the radiation of moments current lifetime in the low region of a bipolar diode is thought to be the cause of permanent damage in bipolar transistors.  
Hughes noted field effect transistors for the inherent permanence and

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found them no better than the best high frequency resistor for this environment. MacCall says he anticipates improvement, however, at the volume of their chronicle-gate regions are believed to be more advanced devices. Sawadash better response was noted on the left of two field effect transistor made by Sawadash. The latter one, which had smaller geometry, was found to be less sensitive.

MacCall contends that a complete threshold circuit, including isolated device, which could be made in a continuous threshold process, would be superior in the transient radiation environment to either bipolar or unipolar field effect devices. Until such a device is possible, he suggests the hybrid threshold circuit for applications requiring equipment operation in the transient environment.

The work awarded by the group here primarily used the Hughes Research Laboratories Accelerator (LARC) which provides gamma rays up to 10<sup>10</sup> Roentgens/sec. Some transient and permanent effects work has been run at Goddard.

To obtain gamma rays from the LARC, a tungsten target is mounted at the end of the LARC, and accelerated electrons striking it are converted to gamma rays by the so-called bremsstrahlung (braking) effect.

The isolated devices are situated in a 3-in. dia. circular sphere of a copper box.

About 1 ft high and 2 ft long, the box shields experimental components from electromagnetic radiation that accompanies the radiation. A shielded counter follows the shielding instrumentation.

The Hughes Labs. gamma pulse width selection from 0.1 ns to 100 ns, but for the experiment with a pulse length between 0.15 to 5 ns, a 100 ns pulse width selection leads to an energy spread from about 1 to 10 eV, somewhat more energetic than a beta spectrum. The LARC setup, however, allows a "moderately good simulation of the gamma spectrum of a nuclear explosion" according to Hughes. MacCall notes that bremsstrahlung is 10<sup>10</sup> to 10<sup>11</sup> Roentgens/sec, but rates up to 10<sup>10</sup> Roentgens/sec are possible if electrons are used directly.

Plans for future investigations of transient radiation effects on microcircuits include:

- Getting better statistical data by testing more devices from a greater variety of manufacturing sources
- Examining field effect devices fabricated integrally in silicon device microcircuits
- Testing more threshold radiation gate transient devices

## FILTER CENTER

► **Coastal Corp.** makes study antenna—Contract testing about \$150,000 have been awarded by Communications Satellite Corp. to three companies to conduct development studies of different techniques for providing multiple ground stations with simultaneous access to a communication satellite system (AW July 22, p. 18). Awarded to American Telephone & Telegraph Co., Hughes Aircraft and Radio Corp. of America. AT&T will extend previous studies which are used in each ground station, conducting its own output, while RCA will investigate use of a beamformer within the satellite. Hughes will study multiple access problems for a synchronous-type satellite including use of a frequency reuse for simultaneous amplification of 500 separate channels. The RCA and AT&T approaches are applicable to medium or synchronous orbit satellites.

► **Fluor-Thermoblastic Cells** Disappearing—Results of tests of small thermoblastic joints built by General Atomic and built on two Air Force installations were convincing before completion. G. W. Glushko, USAF's Aeronautical Systems Div., reported at

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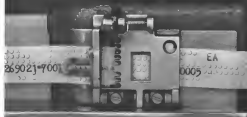
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AVIATION WEEK & SPACE TECHNOLOGY, August 15, 1973

109

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the Aerospace Support Conference. Power output fell off sharply after launch and deteriorated 25% by the 11th edge for the three main. Based on earlier laboratory tests, Chouhara estimates the trouble to metal bonding problems. He concludes that performance must be improved by a factor of 5:1 in terms of life and power-to-weight/rates into below such that three-electronic ponds will be suitable for most space applications.

■ **Army Contractors Install Guidance.**—Army has contracted all of its research and development in aerial guidance systems at the Army Missile Command, Huntsville, Ala. The aerial guidance activity will be reconstituted as Army Aerial Guidance Management Technology Center at Redstone Arsenal, Huntsville, Ala.

■ **Fun-Fang Baby Laser-Rube** laser which fires at rate of one pulse per second with output power of two joules per pulse, is now commercially available from Moss Optics, Inc., 89 Brighton Ave., Boston, Mass. Company claims it is the fastest-firing ruby laser on the market.

■ **Automatic Voice Reports Minimize Trouble.**—When a failure occurs during automatic checkout in an unmanned Minuteman ICBM site, a red light flashes on the console of a branch control center to alert human operators, who dial the facility site and receive a voice report from a tape recorder which describes nature of the trouble. The device, known as voice reporting signal assembly (VRSAs), produced by Northrup's Norstrom Div., is model number of the voice interpretation priority system (VIPS) which program developed for use on the B-58 to tell the pilot when one of 70 potentially hazardous conditions existed. The Minuteman VRSAs contain 70 typed messages. The appropriate message is triggered by the particular sensor or combination of sensors which detect the malfunction.

■ **USAF To Test Latest In Vacuum-Assisted Systems.**—Dew and test laser characterization under space conditions in a 31 ft long, 24 in vacuum chamber recently completed at Wright-Patterson AFB, Ohio. Chamber contains five viewing ports at 30 in intervals along top of the chamber. ASD currently is funding about \$4 million in laser technology, primarily through its Aerospace and Materials Laboratories. This year includes:

- \$4.5 million for 30 fundamental studies to develop laser materials and review propagation characteristics of coherent optical radiation
- \$2.75 million for 40 research projects

aimed at developing diffusion types and configurations at a number of different laser devices, including the development of modulation and demodulation circuits.

• \$1.75 million for programs to apply laser to military applications such as communications, radar, navigation and guidance.

■ **Auto-Checkout Equipment Pays Off.**—Use of automatic checkout equipment can cut spend testing of aircraft systems equipment but also reduces significantly the lagtime lead by studying malfunction equipment manually, according to report given at recent International Aerospace Support Conference in Washington. Howard J. Aard, Jr., Honeywell's Assistant Director, said that 30% of the LAIS low altitude landing system components received from F-104 usually using manual check-out equipment, were found to be in good working condition when returned for repair, compared to only 15% for a similar LAIS system used on the aircraft's Marshall Space Flight Center. Besides a supplier of similar equipment for the Saturn I vehicle.

Flight control system from the mission which used manual testing, Aard reported.

■ **Col. Lowell Eaton Microcircuit Field.**—Col. Arthur C. Lusk, who spent 10 years of Naval Weapons program to incorporate microcircuits in its current equipment changes, has retired from the Marine Corps to become president of nonhazardous company, General Mass Electronics Corp., Santa Clara, Calif. Other programs include David B. Bobb, Robert H. Nazzari and Philip Ferguson formerly employed at Fairchild Semiconductor Div. Now has intends initially to specialize in microcircuits for special purpose computers, according to Lusk.

■ **Signed on the Dotted Line.**—Major contract contracts signed outside the following:

■ **Boeing Defense-Power Division,** Teleson, N. Y., will supply four stabilized platforms for Series 7B and 5 bascule, under \$9 million contract from National Aeronautics and Space Administration's Marshall Space Flight Center. Besides a supplier of similar equipment for the Saturn I vehicle.

■ **Linington Electronic Corp.,** Montgomerieville, Pa., will manufacture electro-optical systems suitable for high-energy batteries under \$100,000 award



## Microcircuit Device Provides 1:1 Scale

Veriflex provides microcircuit layout analysis for planning etching-wire network model as glass is sufficiently accurate to permit working at 1:1 scale for many applications without further photo mask reduction, according to manufacturer. Glass plate covered with dark emulsion is mounted on etchable back-lighted work surface with edge marked in 0.5-mil increments accurate to within 5 sec of an inch. Optical positioning and reduction permits formation of etched holes in 0.001 in., with line widths held to 0.0005 in. over 20-mil diameter pads, according to manufacturer. Veriflex Inspection Products Co., 112 Central Ave., Lynn, Mass. Veriflex is being used by number of systems manufacturers, including Bendix International Business Machines Corp., Hewlett-Packard, Fiat & Whitney Aircraft, Raytheon and Sperry. Manufacturers will hold sessions at Space Flight, Sept. 9-11, to demonstrate the techniques to interested companies.

# CLASSIC JOBS OF MEASUREMENT

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*A Foreword by  
Dr. Walter East  
President, Electro Instruments, Inc.*

"If you make it, we'll find a way to measure it." Our bench engineers know measuring me. I like their spirit, even if it has been costly to me in the way of expensive dinner bills!

It was with a measuring bench through that Electro Instruments was born. Our original stepping switch Digital Voltmeter was the first to substitute electronically direct switches for mechanical and similar movement devices. It quickly proved itself an ideal instrument for scientists, some scientists, more reliable measurements—with useful applications in many industrial operations.

Since that time we have pioneered 20 other electronic "firsts."

These have led to ways of relating many other measuring systems. But, more important, they have extended the areas in which our instruments, and our systems, can serve industry.

The end result for which industry employs them should be accuracy. So it is personal. Time, materials, personnel. Looking through our "own horizons," I can see a number of outstanding examples of measurement offered by me of Electro Instruments.

I thought we might usefully present them to industrial engineers, executives, researchers, and also those might consider for their own operations.

Many modern, I appreciate, will have industrial measuring problems with different than those cited in the examples. On this point, if there are engineers are worth to question: "You make it, we'll find a way to measure it!"



Electro Instruments' self-stored Digital Multimeter brings greater speed, higher reliability in many jobs of measurement, and at a lower investment.

Teleworking a job that once required 500 man hours and a 220V line requires is no more! Yet a single employee at Electro Instruments' Digital Multimeter accomplished just that—for one of America's major scientific companies.

What was involved was the testing of printed circuit cards. Each of 1000 cards produced daily by the company had to be given 50 separate tests for quality. It took an experienced electronics technician and sometimes 25 to 45 minutes per card to perform the job.

In the interest of speeding up this tedious job, experiments with an automatic electronic testing machine were begun. The eventual solution proved to be a punched tape testing—described, accordingly, by one of the company's engineers—with an Electro Instruments Digital Multimeter employed as a key component.

Each of the 1000 cards are now given the 50 separate tests in just 20 minutes—much faster than the original job of a technician. ("Name on request")

In many industrial operations no overall identification of components, and the purpose of operating them. Used in conjunction with newly developed electronic modules of existing machinery to a state of plausibility, Electro Instruments' X-Y Recorder have proved a means of producing visual display of spectra without need for photographic equipment or processes.



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## Vertical Displays Have No Moving Parts

Self-stored vertical display indicators with no moving parts will be built in Leon Sighe's Instrument Division contracts from Air Force, Navy and National Aeronautics and Space Administration totaling \$100,000. New type displays offer faster response, use less power and are expected to be more reliable and readable. Under ONV contract, Leon Sighe Instrument Division will build type indicator to compare amounts of liquid-gas occurring in spacecraft tanks with oxygen and fuel needed to complete planned mission of orbit. They contract for three rapid performance indicators to display, control gas temperature, fuel rate and engine gas. National Aeronautics and Space Administration will get five instruments designed to operate from digital computer and display spacecraft flight and engine data.

from NASA's Lewis Research Center

• Radio Corp. of America will conduct program electronics study to design communications control center for multi-communications satellite under contract by Army Airforce Communications Agency. Center is to schedule analysis, design, among many ground terminals.

• The Hughes Co., Ft. Worth, Tex., will build AN/ARC-16 communications aircraft for use on Apollo spacecraft C-141 transport-craft under \$1.3 million contract from Aeronautical Systems Div.

• Aerospace Instruments Laboratory will design and build data-handling system for use on Apollo spacecraft under contract to North American Aviation's Space and Information Systems Div. Aircraft will handle, store, transmit, store and display information

HF and VHF bands. Antennas will be linked around spacecraft payload dock and payload is released by a single, allowing it to spread and spread into operating position.

• TRW Electronics Pacific, Redwood City, Calif., will develop phase-locked loop of the having 10 to 300 power at 150 sec. and another unit capable of delivering 100 W power at 100 sec. under two-millisecond time delay. Electronic Materials Agency. Transducer unit to be designed to operate from 28 vdc.

• General Precision Aerospace, Kramlet, Pa., Little Falls, N. J., has received additional funding, for total of \$2.7 million, for development and production of airborne computer used in the New North American A-10 (A-10).

• Sierra Electronic Products Inc. will develop J17 and J18 avionics equipment

of understanding nuclear tests under \$494,650 contract from Rome Air Development Center. Work will be performed at Waltham, Mass.

## NEW AVIONIC PRODUCTS

• Sigma cathode ray tube, developed for use in airborne communications equipment, will present multiple simultaneous displays on a 10 x 12 in.



rectangular tube from Tube, which measures 21 in. long by 4 1/4 in. wide and is suitable with a P7 phosphor. Manufactured by Sigma Electronic Products Inc., Electron Tube Div., Secaucus, N.J.

• This-Plus digital instrument, capable of performing logic functions at rates above 10 mc, includes (a) double rate direction from top; (b) pulse shape-line driver and double memory, a



NAND, AND and OR gate, a one that and a bistable multi-threshold, and an independent 1-10/15 AND gate. Available as a tapped digital delay, with two 10,100-1,000 nanoseconds in two units.

Each module measures 4 1/2 x 0.5 x 0.085 in. and is designed for operation over ambient temperature

range of -60C to 125C. Manufacturer: Vem, Inc., 2364 Walnut St., Garland, Texas.

•**High-speed photometer.** Model 417, has an time of only 20 millisecond and one micro-microsecond; with zero drift quoted at less than 1% in eight hours. Instrument operating



range is from  $10^{-10}$  amp. to 30 microamps. Accuracy is quoted at 1% by the company. Manufacturer: Keithley Instruments, 12615 Euclid Ave., Cleveland 6, Ohio.

•**Ultrahigh-speed pulsed light source.** Model STU-92, for use to transmit photo-induced phenomena experiments has applications to research in organic and semiconductor material behavior. Instrument contains a Kerr cell pulsed which provides arbitrary optical pulse shapes from a flash lamp whose output duration and triggering are in the nanosecond time range. The

available, pulsed shape is a triangular waveform for semiconductor testing. Amplitude is a 100 microsecond pulse which can be changed at its peak intensity with a full time of less than 5 microseconds upon command. Optical system an available reflector for narrow band operation from 0.42 to 0.7 microns or for wideband use from 0.12 to 1.2 microns. Manufacturer: Electro-Optical Instruments, Inc., 932 South Myrtle Ave., Mesa, Arizona.

•**Microamp ammeter.** Model 0755, is thermocouple, sealed case requires 0755 in dc measuring hole and measures 1.6  $\mu$  in, long including terminals.



Instrument, which can function in position, null or measuring indicator, is available with accuracies as low as 10 microamps. Manufacturer: The Top Left Electrical Instrument Co., Bedford, Ohio.

•**Permeable spectrum analyzer.** Model SPA-12 covers band from 10 mc. to 64 gc. (dec) in seven bands, with rated minimum sensitivity of at least



signal 100 dbm for the 10-30 mc. range and of more 90 dbm up to 64 gc. Tuning dial is accurate to within 1% with manual control-controlled markers for higher accuracy. Manufacturer: The Sager-Melick Div., The Sager Co., 815 Penske Rd., Redwood, Conn.

•**Wideband antenna subcoupler.** Model 300, for use in high-frequency (HF) communications on direction finding, uses all solid state construction and

permits operation of up to eight channels simultaneously from single antenna with output isolation of 30 db, according to manufacturer. Cost is \$14 over the 3-12 mc. band. Device measures 9 x 11 x 15 in. deep, weighs 5 lb. and measures 17 in. Manufacturer: Tusk Electronics Co., Inc., 99 Danbury Road, Wilton, Conn.

•**Micropower silicon transistor.** Type 2N2784, with typical total switching time of 17 microseconds in saturated current applications, provides a gain

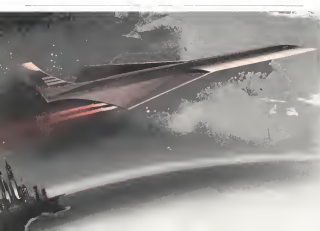


bandwidth product of more than 1 gc. (line). Transistor, which uses new three stage germanium configuration, has a typical beta value of 70 at 5 ma according to manufacturer. "Germanium-to-germanium bonding is used in this new, ultrahigh-speed, rugged, plastic package design. Manufacturer: Siliconix Electric Products, Inc., 100 Sycamore Road, Walnut, Miss.



### Light-weight X-Band Tubes Introduced

New type traveling wave tube, called single-circuit klystron, has 30% lower noise figure than conventional permanent magnet (PM) type. weighs less than half as much because no heavy shielding is required when used in proximity to other traveling wave tubes or magnetic security devices. General Electric has introduced new family of traveling wave tubes with five models operating in X-band region, with noise figures as low as 0.5 db and output up to 5.5 db. The single-circuit traveling wave tube will be applied to Chaffin tubes and later to submillimeter traveling wave tubes in the 12-40 gc. (dec) band. General Electric says.



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A NATURAL COMBINATION, when you consider Sundstrand's capability to meet the technical and economic requirements for constant speed drives in aerospace transports.

Through experience accumulated during the high mach performance of such key military aircraft as the B-58 and F-106, Sundstrand Aviation has compiled data on thermal considerations in high temperature operation. Concurrently, considerable information has been tabulated during in-house environmental testing of the secondary power generating sys-

tem for the XB-70 air vehicle.

Sundstrand Aviation has provided constant speed drives for most of the major commercial jetliners spanning the globe today. They include the Boeing 707's, Douglas DC-8's, Boeing 720's, in addition to the new BUD Caravelle Super RB, Boeing 737, and the forthcoming Fokker F-28.

Now Sundstrand, with its extensive background experience and advanced technology, is actively working to meet the challenges of tomorrow's commercial jetliner—the SST.

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DIVISION OF SUNSTRAND CORPORATION, ROCKFORD, ILLINOIS

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Orlando in Paris; Frankfurt; Stockholm; Sweden.



Checkout procedure on a newly manufactured space vehicle—in its early components, subsystems and finally, complete system—have until recently been a manual task. The complete performance of each item was recorded, then either processed and analyzed using entirely manual techniques, or run through computers, translated into digital language, and then manually interpreted and compared with predetermined optimum standards. Two to three weeks often elapsed before final approval could be given.

With the Lockheed-developed AUTO-DESK system—Automatic Data Recording and Processing Equipment—checkout time has been cut to a few days. The key to this time and labor saving system is simple: A "Tilt" device has been

installed between the checkout signal and the analog AUTO-DESK thus produces an "excitator" report—a printed indication of which functions are performing within preassigned limits. This advanced technique—which makes use of a real time, on-line digital computer—eliminates the need to manually examine some 80% of the data.

With this system, engineers at Lockheed Missiles & Space Company are now able to process data at the winding rate of 40 Kc in real time. Based on these principles, Lockheed is also operating the VARS system, currently performing launch readiness functions at the Pacific Missile Range. A further extension of this concept is being developed to process the telemetry signals of a vehicle in flight.

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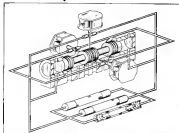
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## LOOK AT LOCKHEED... IN AUTOMATIC CHECKOUT

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## EQUIPMENT



**SCHEMATIC OF MAGNAVALVE** servo valve developed by Moog Servovalves, Inc., East Aurora, N. Y. Schematic shows first-stage amplification and single redundant first stage of booster hydraulic amplifier (booster). In second operation, these channels operate in parallel.

### High Reliability Servo Valve Design Has Parallel First-Stage Channels

MagnaValve servo valve, developed by Moog Servovalves, Inc., East Aurora, N. Y., is designed to provide high reliability, demanded for manned space flight and eliminate need for duplicate systems in redundant hydraulic systems.

The MagnaValve servo valve is a two-stage hydraulic amplifier with three parallel first-stage channels. MagnaValve servo valve concept is based on the automatic redundancy of a single failed channel by the remaining two channels. The servo valve, which is packaged in a single unit, provides the same order of reliability as a completely redundant system with no automatic time lag involved in switching from one system to the other, according to Moog.

#### Normal Operation

During normal operation, the three channels of the first stage operate in parallel at the same time during a single, second-stage spool, which enters hydraulic fluid to the driven element. Effect as active as power failure is any one of the three first-stage channels would result in the redundancy channel being activated by the other.

In the event of a single channel failure, both have shown that non-normal operation can be maintained. Primary degradation is flow gain, which falls off in the null area in a region of

about 13% of full signal. Within this region, flow gain is reduced to 67% of normal. Outside the region, flow gain is normal. Thus, in event of single channel failure, unit can operate within normal response time, according to Moog engineers. MagnaValve of maximum valve speed control shift is approximately 5% of the full signal in the active channels and does not adversely affect control operation. Unit would still operate if two of three channels failed but at reduced efficiency, depending on type of failure.

#### Rate Force Techniques

Reliability in the single normal stage is increased by what Moog calls a lever force technique to overcome jamming due to particle contamination or built-in leaks. Spool has been made considerably larger (approximately 5.1 in. dia.) than standard spool (approximately 0.15 in. dia.) so that higher driving forces are available to break loose contamination at entering edges or adjacent to the sliding surface.

It is felt that driving forces of the order of 400 lb., (1,000 psi. reaction), when applied to an extremely hard spool with sharp entering edges, should be sufficient to cut through any reasonable expected contamination. Failure protection, suggested by



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# INTERNATIONAL AIR TRANSPORT ISSUE

October 7, 1963

To meet the information challenge created by the international character of aviation, **AVIATION WEEK & SPACE TECHNOLOGY** publishes each year at least devoted to international air transport progress. This issue is received with such enthusiastic response that it will again be greatly expanded to provide the most comprehensive analysis and forecast of the air transport industry and its technical developments.

Publishing date is October 7, 1963, timed to coincide with the annual general meeting of the International Air Transport Association (IATA) in Rome. Copies of the issue will be flown to Rome for distribution at the opening plenary session to airline presidents, IATA delegates and other world aviation leaders.

Issues there will be the current problems in international air transport including bilateral agreements, rates and tariffs, flight equipment, passenger, mail and cargo traffic, air traffic control, the capacity issue, exchange of international routes. Other subjects essential to a full analysis of the airline industry world will be stressed including trends in supersonic transport development, military transport operation, survey of Russian and Communist Bloc airline activity, impact of U.S. international transport policy on world political and industrial relations.

Feature treatment will be given to trends and projected future prospects for traffic growth and development of flight equipment in all major world markets. North and South America, Atlantic, Pacific, Europe, Africa, Middle and Far East. Ample illustrated, it will also contain specially prepared charts and graphs to show growth and forecast trends.

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## MERGERS AND ACQUISITIONS

**Little Industries** and General Mills report their boards of directors have approved in principle the sale of General Mills' aerospace research and engineering department in Minneapolis, Minn. for an undisclosed sum of cash. General Mills facility employs about 100 people engaged in R & D work in super atmosphere physics, aerodynamics, communication sciences, and rocket, space and materials research.

**Consolidated American Services, Inc. (CASAM)**, Hawthorne, Calif., a supplier of non-destructive testing, missile cleaning, and nuclear decontamination services, has acquired the assets of Pacific Management Corp. in a derivatives move. FMC has a contract with the Air Force for the operation of its facilities at Wake Island. The acquisition was for an undisclosed amount of stock.

**Telechem, Inc.**, Hawthorne, Calif., and **Reagan Engineering Corp.**, Gardena, Calif., are planning a merger. The transaction, subject to approval of stockholders and the California Commissioner of Corporations, would involve a stock exchange.

**Analogous-Ray Electronics Corp.** has acquired a substantial minority interest in Dai Nippon Denso Kogyo K. K., a joint venture company formed in Tokyo to manufacture electronic and electrical components.

**Thompson Radio Wreckage, Inc.**, has sold its Dage Television Div., even between all closed-circuit TV, to Hays-Wells Corp. for an undisclosed sum. The division will continue operations in Michigan City, Ind., as Hays-Wells Co., a division of Hays-Wells.

**Aero-Clathron Corp.** of New York City has acquired the A. H. Enery Co. of New Canaan, Conn. for \$3,000 shares of Aero-Clathron common stock and 34,750 shares of newly created 8% preferred stock. A. H. Enery Co. manufactures hydraulic load cells for testing instruments, including ship design and industrial equipment.

**Imperial Thermal Systems, Inc.**, of Brea, Calif., has acquired the Thermal Systems Branch of Advanced Electronics, a Div. of Telecomputing

Corp. for an undisclosed amount. The acquisition extends Imperial Thermal Systems' capabilities in the aerospace and military ground support field.

**VSI Corp.**, Pasadena, Calif., has acquired the assets and business of Winterton, Inc., Hawthorne, Calif., for an undisclosed cash sum. Winterton manufactures road relay and related products. The new acquisition will be operated as the Winterton Div. of Michigan Magnetron, Inc., Van Nuys, Calif.

**Perlette Div.** of Martin Marietta, a manufacturer of aerospace systems, has been acquired and is being operated as a division of Instrumentation Corp. It was acquired in a Whelan transaction.

**International Telephone and Telegraph Corp.** has agreed on terms for the acquisition of Calsion Electric Co., Los Angeles, Calif. Calsion makes plug and socket assemblies for industrial, commercial and telecommunications use. The acquisition is subject to approval by stockholders of Calsion and the legal consents of both companies.

**IMC Industries, Inc.**, Memphis, Tenn., has purchased Airborne Electronics Inc., also of Memphis, through a stock exchange.



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## WHO'S WHERE

(Continued from page 23)

### Changes

General Dynamics/Aerodynamics, San Diego, Calif., has named the following as chief engineers: Ernest Wade—electrical and electronics; David J. Papp—structures; Michael Dallas—light aerodynamics; Paul D. Fries—of aerodynamics.

A. F. Johnston, public relations manager, Harco Safety Group Limited, London, Hants. & Co., has been named as chief engineer, Robert H. Holliday, director of military engineering, Motorola Systems Corp.

Dr. Richard F. Highland, director of Purdue University's aerospace science laboratory, Lafayette, Ind.

Dr. Robert B. Spenser, director of research and development—aircraft and space activities, General Motors AC Spark Plug Div., with headquarters in the El Segundo (Calif.) laboratory.

James F. Orr, manager, Industrial Div. of Trenchard, Waltham, Mass., a division of Laboratory Electronics, Inc.; David K. Hut, assistant director—engineering product services and design, Research and Engineering Div. of LFE Electronics, Boston, Mass., also a division of LFE.

Carl M. Segel, sales manager, Teknical Sales, a division of Teknical Electronics Corp., Corp. Men, Calif.

Walter J. Resnick, head, Product Development Dept., Winchell Div. of Thales Chemical Corp., Brighton City, Utah.

Dr. Philip Kemp, project engineer—Lance Missile Project, Donner Div. of Lockheed-Douglas Corp., Goleta, Calif.

Charles W. Garton, manager of systems, airframe and military sales—Purdue Div., Texas World Airlines, Inc., with offices in Los Angeles, Calif.

Walter B. Kessler, assistant, appointed marketing consultant to ELM Royal Dutch Airlines in the U.S. Prior to leaving his position consulting firm, Mr. Kessler was vice-president—sales and sales of Southwestern Airlines System, Inc.

Dr. Donald H. Koss, senior research scientist, Department of Electronics and Electrical Engineering, Southwest Research Institute, San Antonio, Tex.

Dr. Samuel H. Bush, head, Reliability and Statistics Dept., Engineering Div., San Bernardino (Calif.) Operations of Aerospace Corp. Also Frank Balle, director of systems, Mobile Missile-Ballistic Missile Program (MMB/BBM), San Bernardino Operations.

E. K. Humphrey, chief of design and sales operations, Laid Jet Corp., Wichita.

Donald F. Swanson, director, Application Engineering Div., Hewlett-Packard Electronic Division, Palo Alto, Calif.

Donald L. Haddock, manager, Western Regional Office of Palco Corp.'s Aeromarine Div., Newport Beach, Calif., succeeding Doug C. Gorman, vice president—development engineer in Aeromarine's Research Laboratory. Other Aeromarine appointments: James A. Twiss, manager, Air Force Programs, Eastern Regional Office, Washington, D.C.; Kenneth F. Olson, assistant manager, Midwestern Regional Office, Dayton, Ohio.

## Aircraft Engineers



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## LETTERS

### That Vexations "V"

In regard to the latest political quiz, "V for Vexations," as p. 21 of the July 5 issue, I am sure our readers' efforts are not so unfruitful as would appear.

For a couple of places that a meaning for "V" could be found: ForType Inc., 11103 N. 40th, and the non-rated railroad men's Amtrak Museum. I'm sure they are aware of these, providing the "old" system were in effect encouraging designers to use the "new" system. I sincerely believe they couldn't have known. The "new" designers are so wonderful to write about, in fact, the "old" designers are so generous that we know the plane's location, owner and builder. Example: TWA (FAA's).

D. B. Foss  
L. USN  
VF 43  
"Jolly Rogers"

### More Victims

Mr. Fellack, I'm certain, speaks for a large segment of professionals at air terminals as he "Idlewild Wonders" (AVR June 24, p. 126). I too have run the terminals and am tired of the last minute by a ten person who was kind enough to ride the loop so we could make connections.

In the same way, Mr. Farnsworth expresses another overheard design in its making, another "Idlewild" with a less complex a mile square. It appears that terminal architects have used the same kind of perspective and engineering studies that shopping plans designers have used to allow use of much expensively for service as passengers.

The economy of single-level construction over multi-level construction will dictate the basic concept of terminal design, and functional design systems to be "collapsible" with the increased speed of air travel programs should make that they now have more time to coordinate between terminals.

R. G. GALLIAN  
St. Louis, Mo.

While referred to Idlewild as a "National Airlines" Electric, running in time late and late being a time connection with American Airlines, I noted with more than casual interest the several comments of Mr. Farnsworth (AVR June 24, p. 126) regarding "the commuters" referred on the traveling public at this "hollow" airport. However, being of several physical dimensions, and determined by Mr. Fellack of the folly of relying on the airport bus, and not being inspired by the "limited utility" offered to the "B-D" design, I found the reading somewhat full of confusion.

Twenty minutes later as I collapsed into a rest room (American's 747, while paying for lunch and staying in its own joint, I was soothed by the shade of the morning rain and I had occasion to arrive as required the preceding day, the terminal had marked my transportation with Idlewild. I noted the significant absence of both signs and terminal personnel which only

*Articles Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Submissions to the Editor, Attention: Feedback, 330 W. 42nd St., New York 36, N.Y. Try to keep letters under 300 words and allow a reasonable identification. We will not print anonymous letters, but names of writers will be withheld on request.*

confuse the traveler with advance direction. And thus as I strolled out into the hot sun there had been the classic New York cab driver asking on a sign of a complex contact for some terminal service. All this had been topped by the desperate loss of explicitness in the non-concrete oval ditch and this lingering way specific instructions as to just where one could put the cross Checker Cab Co. and concluded by the final cliff of seeing the terminal when and where 707 shimmering in the air, visible distance with the enter ramp still closed on.

As the travel of modern air travel? How else could one have traveled in New York, no less at all in New York, and have done so at 11,000 ft. no more to Los Angeles and not have the biggest mess when one's baggage would arrive.

Paul H. Kinnison  
Piquet Hill, Calif.

### Idlewild Tunnels

With reference to your article on the opening Idlewild Airport and the common dilemma which connecting with flights of other airlines (AVR July 18, p. 31), allow me to mention something a group of us who travel were discussing your age when the "inhabitants" were beginning with the Middle East. Some members explain that some on system of administration tunnels be used with moving sidewalks or conveyor systems for lost traffic. Each corner as a terminal was would have a descending and ascending escalator system which connected to an underground parking roadway to a point or "link" that one gets all the "TWA system" with big and goes to the "GAI" or "La Guardia" walking and continues on the top without doing any mention or mention of luggage. To make up the design would be needed to drive the road. Double-type ways, certain alternatives would be at strategic points along these underground highways for assistance purposes.

As to visit, etc. for transporting passengers to other locations—sample as already suggested with traffic.

William C. Hellen  
Pleasanton, Pa.

### European Routes

After reading James R. Ashlock's report (AVR Aug. 12, p. 31) dealing with the new signs below the CAB concerned with that agency's plans to divide the meeting at points in Europe between FAA and TWA, most agree with the statement of the editor of the American way. John B. Flynn, CAB member, has that done many of what I thought were used and discarded ideas.

First off, Mr. Flynn says that American carriers are now getting 41.7% of the North Atlantic passenger business with only 49.7% of the seats. That means we are doing better than our foreign competitors. Yet Mr. Flynn analyzes that it would be better to let some of this to our competitors, which he says will happen under his plan. He even says that the FAA will lose 15,000 passengers, and TWA 1,600 in 1974 under the CAB plan. Is the loss of business good for business? I always thought there was something about the cost cutting drive in the reform went up.

Then, Mr. Flynn says that FAA and TWA should concentrate on a few European points and let the rest go to the competitors. Is the narrowing of the base of a business economically sound? I thought most business men always trying to broaden their base in order to protect themselves from losses in specific areas. Finally, since TWA wants Vice President Cooke to agree with the CAB and to add that FTA and FAA are dropping themselves in competition, when they should really be going up on the top. I thought that competition-based whatever success was always good for business. Isn't that what they keep telling us most of the time? Or is that something only for "public" consumption?

It becomes a strange world when one governmental agency publicly condemns pro-freedom, transportation, cutbacks of markets, at all in "daily business" and what would be about something called free enterprise, open competition, at all, while another agency takes an oath and swears that it is not free at all and starts upon using its extreme power to keep it from happening.

Malcolm George Bower  
Three Rivers, Calif.

### PSA Operation

Your publication serves a little late here in Indonesia, but it should not be too late to comment on your July 1 article entitled "Non-Regulated Operations: Benefits FFA" (p. 46). It also illustrated the title. It should be a "double-edged sword."

I was intrigued to see such an article, not without any hint of the controversial aspect of PSA. It was not obvious to all that the company stopped at and discussed the crime of the Interstate Los Angeles-France market, but by the post-mortem you apply in the article but merely by converting the normal process of law which must be adhered to be established at all.

If this company were required to play the game by the same rules as those opponents that they might also know that it is not disadvantageous and cover the airline business. Your article gave a distorted picture, and also must be interpreted as a condemnation of CAB and FFA regulatory measures.

Chris F. Brown  
Torchwood Airways  
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